DISCOVERY

A Monthly Popular Journal of Knowledge

August 1937 — One Shilling

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Notes of the Month

The 42nd Annual Report of the National Trust for Places of Historic Interest and Natural Beauty, recently issued together with their Index of Freehold and Leasehold Properties, etc., is an interesting and in many ways a heartening document. Among important developments during the past twelve months has been the promotion of a Bill in Parliament empowering the Trust to hold as endowment land not necessarily of natural beauty or historic interest, which has resulted in the formation of the Countryside Trust, a company ancillary to the National Trust itself, but not restricted by the conditions attaching to a technically charitable organisation. At the same time a scheme, arising out of one modelled on the work of *La Demeure Historique*, in France, is in hand for the protection of historic country houses and estates.

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Among important properties for the acquisition of which the Trust has recently launched appeals, Glastonbury Tor is nearest the goal; but the appeal is open only until September and a special effort is required to complete the relatively small amount outstanding. The purchase-money for Moreton Old Hall, one of the finest half-timbered buildings in the kingdom, has been generously furthered by Lord Leverhulme, but much more is still needed. Notable new properties include the galleried George Inn in Southwark, the ruined Hayles Abbey in Gloucestershire, and a whole island, the Calf of Man, which will be held primarily as a bird sanctuary and will be closed during the breeding season. The Northern Ireland section has made excellent progress, perhaps the most notable acquisition being the earthwork called the Rough Fort, at Limavady, on the main Belfast–Derry road.

* * * *

The Society of Chemical Industry held its annual meeting at Harrogate towards the beginning of July, when a survey of trends in chemical science during the past sixty years, and of present-day tendencies, was given by Professor G. G. Henderson, as the Society's Medallist. Professor Henderson is Regius Professor of Chemistry at Glasgow University, and in 1888 was responsible for arranging for the first annual general meeting of the Society, held in that city. In his address he surveyed the results of the theory of ionisation, first definitely advanced by Arrhenius in 1887; of the separation of the "rare gases" from the atmosphere; of the discovery of radio-activity and X-rays, leading to the modern theory of the atom, and also to the possibility of "producing experimentally new elements which, so far as is known, do not occur in nature"; of the filling of missing places in the table of chemical elements; of the growing success of biochemists in exploring the chemistry of the body's working; and of the addition of X-rays, ultra-violet and infra-red radiation, and of the delicate weapon of micro-analysis to the analyst's armoury.

* * * *

"Applied chemistry also, in every department," he proceeded, "has advanced with giant strides. Before the Great War some branches of chemical manufacture, such as the production of dyestuffs, of synthetic drugs, and of fine chemicals, had become to a large extent the monopoly of our competitors, but since then the development of the chemical industries of this country has been most gratifying." Among outstanding technical changes, he listed the extending use of electrolytic methods; the use of very high and very low temperatures, and of very high pressures; and the employment of catalysts on a manufacturing scale. "In past years, as often as opportunity offered," Professor Henderson concluded,

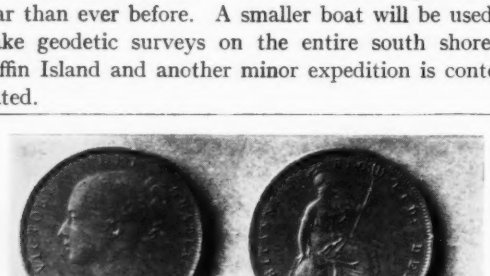
"I have given expression to my conviction, which probably is shared by every chemist, that the future prosperity of our country is largely dependent on the support given to the progress of science, and especially of chemistry. But individuals cannot exercise any appreciable influence in such a matter, and it is only if chemists as a united profession can speak with one voice that their views are likely to be considered by our legislators, by Government departments, and ultimately or primarily by our fellow citizens."

* * * *

The record long-distance flight of the Russian airmen on the Arctic air route between the U.S.S.R. and North America gives interest to the work performed annually by the Canadian Government in patrolling posts in the eastern Arctic. The patrol has three principal objects: to leave no doubt as to Canadian sovereignty of Baffin Island, Ellesmere Island, Devon Island and all the other islands of this mighty archipelago by establishing services on them; to conduct scientific investigations into the topography, geology, and meteorology and ice conditions of the islands as well as the plant and animal life; and to care for the Eskimos, several thousand of whom live on these islands, and to bring supplies and relief to the members of the Mounted Police who from their lonely outposts dispense help and represent law and order to the natives.

* * * *

Regular annual patrols have been carried out since 1922 and each year more information has been added. Direction-finding stations have been placed along Hudson Straits and the Commander of the patrol is now able to telephone from his ship by wireless to the various stations in the Straits and in Hudson Bay. Maps have been greatly improved. To meet the greater public demand for information about the north, particularly with the development of flying, the activity in the Arctic by the Dominion Government will be greater this year than ever before. A smaller boat will be used to make geodetic surveys on the entire south shore of Baffin Island and another minor expedition is contemplated.



The most recent "ancestor" of the penny of to-day: the Early Victorian copper penny, described in our first article this month.

Nowadays, when the mutilation or obscuring of so much of England's historical heritage is proceeding apace, the activities of local Field Clubs cannot be too actively encouraged. We have just received the *Proceedings of the West Cornwall Field Club* for 1936, and we should like to see similar publications from local societies all over the country. The West Cornwall *Proceedings* fill a modest pamphlet, and nothing is attempted beyond a concise record of work done and in hand, and comments on the year's activities. The future policy of the Club is to establish a detailed chronology for the years 500 B.C.-400 A.D.; and what is now required is a centre in which such data could be correlated with similar information from other districts. It would seem that such a function would not fall outside the bounds of the Anthropological Section of the British Association.

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DISCOVERY, in common with the world of learning in general, has suffered a great loss by the death of Dr. Cloudesley Brereton, whose genial and helpful presence on the DISCOVERY Committee was always a source of inspiration and encouragement to his colleagues. Dr. Brereton was especially an authority on France, and a series of his broadcast addresses on that country, published in book form, was awarded a special prize of 15,000 francs, as announced recently in our columns. With characteristic generosity, he handed the prize money over to the University of Lille for the endowment of an annual award. Dr. Brereton's work in the cause of education, especially directed towards the better teaching of modern languages, is well known; and as a practising farmer he was able to speak with authority on the vexed problem of home food production. Such versatility as his is becoming increasingly rare, and it will be long before his place can be adequately filled in the march towards genuine progress.

* * * *

The last month has brought the death of two of the foremost men of science, Senator Marconi, and Professor H. E. Armstrong, senior Fellow of the Royal Society. The latter, who died at his home in Lewisham on July 13th, was probably the most prominent figure in British Chemistry. He was 87 years of age, and was elected a fellow of the Royal Society in 1875. Professor Armstrong was awarded the Davy medal of the Royal Society in 1911, the Messel medal of Chemical Industry in 1922, and the Albert medal of the Royal Society of Arts in 1930. He was a doctor of philosophy of Leipzig University, doctor of laws of St. Andrews, and doctor of science of Madrid and Melbourne.

The Ancestry of the Penny

By Philip V. Hill

Now that the new British coins bearing the head of King George VI on the obverse has come into the hands of most of his subjects, some notice of the origins of the most popular and frequently handled of them all are not out of place. Mr. Hill here speaks with authority on some of the most recent discoveries concerning the ancestors of the penny, both proximate and remote. The coins reproduced herewith are shown five-sixths of their actual size.

Not even Buddhistic contemplation of a penny would ever reveal the long and varied history which that modest coin possesses—a history extending through 2600 years and dating back to the very beginnings of coined money. To link the modern bronze penny, of inferior metal, with the earliest silver staters of Classical times would seem a fantastic, almost a Chestertonian, paradox.

Yet such a link can be forged and here (after the fashion of the melancholy Jaques) we shall trace the "Seven Ages of the Penny" from the Ægina of the 7th century B.C. to the England of the 20th century A.D. We shall also study the seven names it bore during that period—stater (or didrachm), denarius (or argenteus), siliqua, denier, penig, peni, penny—and travel in imagination through Greece, Italy, and France to England.

The little Greek island of Ægina, only 40 square miles in area, lies in the gulf that bears its name between Bœotia and Corinth. In ancient times it was one of the great centres of commerce and even to-day it possesses several flourishing industries, notably that of the vine. Tradition says that Pheidon, King of Argos (670-656 B.C.), struck coins for Ægina in silver, the natural metal of the island, with its public seal, the sea-turtle on the obverse; a design which gained for them the name of Χελώναι (turtles or tortoises), though actually the tortoise did not replace the turtle as an obverse type until c. 400 B.C. These coins, from the stater or didrachm to the hemi-obol, enjoyed the distinction of being both the first silver coins of all and also the first coins to be struck in Europe. The tradition has been disputed, but it seems certain that, after many long controversies, we have arrived at the correct theory regarding the date of Pheidon. Whether or not Pheidon introduced coins into Ægina, one fact is quite certain: the oldest Æginetan staters are the most ancient silver coins extant. Thus a Greek island, small though it was (but by no means commercially unimportant) became the birthplace of silver coins. (The idea of coinage, it should be remembered, was evolved independently in China about the same time).

The Classical Ancestors of the Penny. 1. *An Aeginetan chelone* (c.456-431 B.C.). 2. *Tarentine didrachm, with Taras, the legendary founder of the city, and a dolphin* (c. 330-302 B.C.). 3, 4 *and* 5 *show the rise and fall of the Roman coin:* 3. *Early Republican didrachm* (*after* 268 B.C.); 4. *Denarius of Augustus* (27 B.C.-A.D. 14); 5. *Siliqua of Theodosius* (379-395 A.D.).

The second act in the history of our penny is staged in Italy, in the south of which and in Sicily the Hellenes were rapidly founding colonies during the 8th century B.C. The invention of coinage followed close upon this era of colonisation, although the first coins were not struck in Magna Græcia (S. Italy and Sicily) until fully a century later. The silver didrachm (2-drachma piece or stater) of the Greek city states was introduced into the daughter-colonies and became the chief coin of Italy for nearly 400 years, from the 6th to the 2nd centuries B.C. It was somewhat larger than a shilling in size, with an average value of (approximately) 1*s.* 6*d.* in modern English money.

But a mistress was destined to rule over the aboriginal Italian tribes and Greek colonies, hitherto autonomous. Egypt, Assyria, Babylon had all fallen and the decay of Persia was already setting in, but the day of Rome was approaching. The origin of Roman coinage is still obscure and dates assigned by authorities to the striking of the first silver coin are arbitrary. The formerly accepted theory, now exploded by recent research, runs

as follows: In or about the year 338 B.C., mints were set up at Capua and other Campanian cities (then under the rule of Rome) which struck " Romano-Campanian " didrachms and litræ in silver and cast large copper asses and subdivisions in the name of Rome—indicated by " ROMANO " on the reverse. For nearly seventy years the didrachm was the chief silver coin of the Roman state until, in 269-8 B.C., a new coinage was introduced and the place of the didrachm was taken by the denarius. The new coin was so called because it was tariffed at ten copper asses—from " deni " = " 10 each." Its size and types were greatly influenced by the didrachm and the coins of the Greek colonies. In 217 B.C., it was reduced in weight and equated to sixteen asses. The new and more plausible theory maintains that it was the didrachm which was introduced into Rome in 268 B.C. and not, as formerly thought, the denarius, which did not come into being until c.190 B C., thereafter gradually superseding the didrachm*. For the next 500 years the denarius was the most important coin of the Roman world—the standard coin of Mediterranean commerce—until the siliqua was introduced by Constantine the Great in A.D. 324.

The Penny in the Bible

The 17th century translators of the Bible rendered the word δηνάριον as " penny " — " When he had agreed with the labourers for a *penny* a day. . . ." (Matt. xx. 2); " They received every man a *penny* " (Matt. xx. 9); " And they brought unto Him a *penny*" (Matt. xxii. 19). " Denarion " is merely the Græcised form of the Latin " denarius," whose link with the penny is aptly shown by the translators' rendering. It is a well-known fact, hardly needing repetition, that our sign for " penny " (" d ") is but an abbreviated form of " denarius." The " piece of money " for tribute found in the fish's mouth (Matt. xvii. 27) is the stater.

The date 324 A.D. is a notable one in the numismatic as well as the political history of Rome. In that year the Emperor Licinius, upholder of the old paganism, was strangled by order of his colleague, Constantine I, champion of the Christian Church, who had defeated him in battle a few months previously in 323. The disastrous end of Licinius marked the beginning of a reformed coinage in gold and silver, since Constantine, now sole Emperor, could (presumably) introduce his reforms more easily. A gold solidus replaced the aureus and a silver siliqua replaced the argenteus—the name by which the denarius had been more generally known since Diocletian's reform of 296. The new siliqua, rather smaller than the denarius in size, was in frequent use until the fall of the Western Empire in 476: as time went on, however, it was struck less and less frequently.

The barbarian invaders of the Empire during the 5th century made crude copies of Roman and Byzantine coin-types and often " borrowed " the names of the denominations. The denarius was revived, after four-and-a-half centuries of oblivion, by Pepin, King of the Franks, in 755 under the name of " novus denarius " or " denier." It was considerably smaller than its prototype, roughly twenty-four grains (the denarius weighs about sixty), bearing a crude head on the obverse —the " portrait " of the king who issued it. The " portraiture " is comparable with the art on Byzantine coins of the most decadent period, although an improvement upon the Anglo-Saxon pennies, the majority of which displayed the regal features as a travesty of a human face.

Anglo-Saxon Pennies

This leads us naturally to the early English penny and therefore we must cross the Channel to England. Tradition has it that Offa, King of Mercia, successful warrior and great statesman, introduced into England a silver coin the size and weight of the Frankish denier. The new coin was known as a " penny " (Anglo-Saxon: " penig " or " pening "), first so called, as far as is known, in a will of 833 or 835. Offa's friendship with his great contemporary Charlemagne and his visits to the Frankish court may have led to his introduction of this new and improved silver coin into England—a coin which was the direct descendant of the denarius, and therefore of the Æginetic stater. The late Dr. Brooke in his standard work, " English Coins " says: " The weight of the Penny reached twenty-four to twenty-five grains in the reign of Alfred and went still higher under Edward the Elder, owing perhaps to the influence of the Frankish denier through Viking intercourse," thus apparently suggesting that the influence of the denier upon English coins did not make itself felt until a century and more after Offa's time. Nevertheless, however and whenever the penny came to England, it became the sole coin of the poorer classes and remained as such for 500 years until 1279, when Edward I introduced his farthings, halfpennies, and unsuccessful groat.

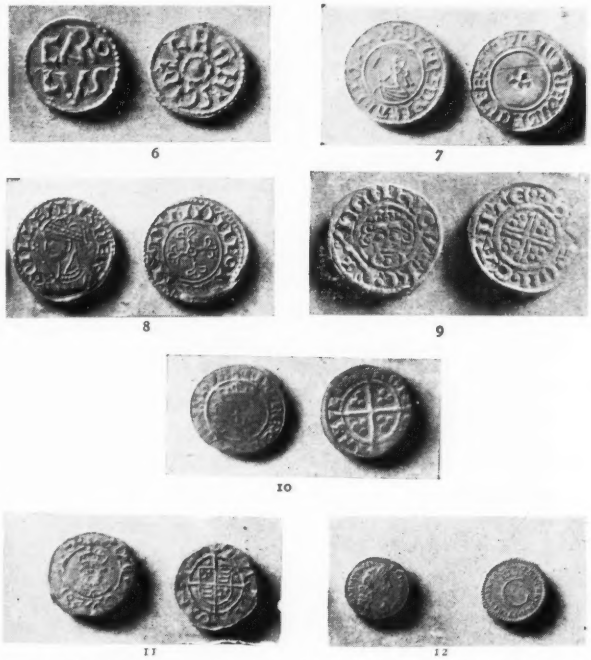
From 1066 to 1279, the weight of the penny (or " peni," as it was called in Mediæval times) remained at approximately twenty grains, except for the nineteen years of Stephen's " reign " when all, even the coinage, was in a state of anarchy. In 1279 Edward I struck heavier pennies of twenty-two and a half grains, but by the end of the Middle Ages the coin had been reduced to a little over half that weight—twelve grains. The

*Those interested may find both the new theory and the case for it in *The Date of the Roman Denarius*, by H. MATTINGLY and E. S. G. ROBINSON, (British Academy, 1933).

regal " portraits " on coins prior to 1279 are ludicrous in the extreme and must be seen to be appreciated ; after that date, art on coins becomes more stereotyped and the same portrait of the king, with no pretence at being a likeness, is in use on all silver coins, with but minor variations, until long after the accession of Henry VII, whose reign is generally regarded as marking the end of the Middle Ages in England. The type persisted on the halfpennies until the second coinage (1526-1544) of Henry VIII.

The penny of Tudor and Stuart times was still struck in silver although from James I's reign onwards copper was being used more and more extensively for striking farthing and halfpenny tokens—not regular issues. The variations in the weight of the penny during this period make an interesting study. At the beginning of the Tudor period it was fully twelve grains ; at the end, it was no more than seven and a half. Pennies of debased silver are found in the reigns of no less than three of the five Tudor sovereigns—Henry VIII, Edward VI and Mary I. Henry VII, with all his parsimony and avarice, did not stoop to debasement of the coinage. It was the unenviable legacy bequeathed to Elizabeth by her father, brother and sister to set right the evils caused by bad money. The slogan of her financial adviser, Sir Thomas Gresham, was (in short) " Bad money drives out good," and this certainly proved to be the case. Coins even more debased than those of Henry VIII were struck by the Protector Northumberland in the name of Edward VI in 1551. Whereas Henry did, at last, content himself with coins of four oz. silver to eight oz. alloy (in every pound), Edward VI struck pennies of only three oz. silver to nine oz. alloy !

In type as well as in weight, the penny underwent many changes during Tudor and Stuart times. In 1485 there was little to distinguish it from the mediæval penny and certainly no attempt at reproducing the features of the monarch ; by 1714, it was a beautiful little coin bearing on its obverse the head of the queen, delicately engraved. In 1485, the penny was rudely hammered : in 1714, it was struck by the neater mill process. Coins struck by this process are known as mill coins—not to be confused with the "milling" (a dangerously confusing misnomer), or, more properly, " graining," on the edges of our modern silver.



From Charles I of France to Charles II of England. 6. *A crude barbarous coin of Charlemagne* (768-814), *son of Pepin the Short, who struck the first denier in* 755. 7. *Anglo-Saxon penny of Ethelred the Unready* (*after* 979). 8. *Penny of William the Conqueror* (*c.* 1067-70). 9. " *Short-cross* " *penny of John* (*c.*1205-10). 10. *Penny of Edward I* (1279), *of a type in use till the end of the middle ages.* 11. *Penny* (1544-47) *with a portrait of Henry VIII in his declining years.* 12. *Charles II penny* (1672), *delicately engraved.*

The year 1504 saw an important change in the types of the silver coins. An entirely new portrait of the king (Henry VII), designed by Alexander of Brugsal, a reverberation upon coin-art of the artistic and intellectual Renaissance, was placed upon the obverse, while the reverse bore the royal shield of arms. The sole exception (in silver) to this type was the penny—the "Sovereign" type—which shows the king seated on his throne, holding a sceptre and orb. The " Sovereign " type was in use until 1543 and was again used by Edward VI in 1549 for pennies of fine silver : those struck in base silver were of the " Rose " type, as were the base pennies of Mary and her husband Philip. Other types in use on the pennies were the full-faced bust and profile of the monarch. James I struck pennies of both the profile and " Rose " types, the latter having on their reverses a large thistle. When Charles I succeeded in 1625, he struck pennies with roses on both obverse and reverse and with the reverse legend : " IVSTITIA THRONVM FIRMAT " — " Justice strengthens a throne "—tragic irony, when one considers the monstrous injustices of the 17th century which combined to undermine the throne and to bring Charles's

head rolling in the dust. During the Civil War pennies were struck at Aberystwith, Exeter, and Oxford. A rare penny of the Oxford mint bears on its reverse the words : RELIG : PRO : LEG : ANG : LIBER : PAR : in three lines with three fleurs-de-lis above and 1644 below. This type refers to the famous declaration of Charles to " preserve the Protestant religion, the laws and liberties of his subjects, and the privileges of Parliament." The inartistic coins of the Commonwealth were known popularly as the " Breeches Issue "—from the conjoined shields on the reverse which have every appearance of 17th century breeches. In less than three years after the Restoration of the monarchy in the person of Charles II, son of Charles I, hammered coins had ceased to be struck and their place was taken by the neater mill coins, the productions of Blondeau's mill machinery.

It was the former belief, now proved to be entirely erroneous, that silver coins from the groat to the penny were struck for Maundy distribution only, during and after the reign of Charles II. To quote yet again from Dr. Brooke : " It was not until 1729, or possibly 1731, that the pieces of fourpence, threepence, and twopence were used as Maundy, and only since that date have they and the silver penny ceased to circulate as currency . . . .The term ' Maundy money ' is only applicable in, and after, the reign of George II." (" English Coins," ¶222). Before 1729, therefore, the penny was the only coin distributed at the Maundy ceremony.

From the year of Charles II's death (1685) to 1729, the penny changed little in type—except for the normal change of monarch's bust and name—and not at all in weight. The reverse type of Charles's penny was a large " C " crowned : that of the pennies of James II showed the Roman " I " crowned, which was altered to the Arabic " 1 " by William and Mary. The Maundy penny of 1729 to 1816 did not depart very much from this general type. That of 1792 is interesting (apart from being rare) since the figures on the reverse are in the written, not the printed, form : this, the second Maundy issue of George III, is known, on that account, as " Wire Money." In 1816, the weight of the silver Maundy penny, which had been $7\frac{3}{4}$ grains since 1685, was reduced to $7\frac{1}{4}$ grains, its present weight. Since 1816 the general reverse type has not changed.

The ' cartwheel ' penny of 1797

For sixty-eight years there was no penny in use in England until the first copper pennies appeared in 1797, great clumsy coins, known derisively as "cartwheels." But this new penny and its companion, the copper twopence, are most brilliantly executed, when one considers them in a rational light—apart from their size. Messrs. Boulton & Watt struck them at their Soho Works, near Birmingham (indicated by a minute " SOHO " below the shield of Britannia on the reverse). They used the new steam-engine which rolled out the metal, cut it into circular blanks (planquets), shook the blanks in bags to take off rough edges, and stamped the coins at the (then) surprising rate of from 30,000 to 40,000 an hour. The fourth copper issue of George III, consisting of farthings, halfpennies, and pennies, was made current on May 7th, 1806 : the coins were struck at Soho by Boulton and Watt during the whole of that year and 1807. They are not so ludicrously large as their predecessors, the pennies being struck at the rate of twenty-four to the pound avoirdupois. This was the rate at which all copper from 1825 to 1860 was struck. No pennies, except Maundy, were minted from 1807 to 1825, when George IV issued copper coins of the same reverse type as those of Victoria which were superseded by bronze coins thirty-five years later. The large copper pennies of Victoria issued during the period 1838-60 are interesting, and different varieties may be found : a ornamental trident ; (*b*) plain trident ; and (*c*) (1858-1860) no engraver's initials—" WW " (Wm. Wyon)—below the head on the obverse.

The smaller bronze pennies which superseded the copper in 1860 are made of a mixture ninety-five per cent. copper, four per cent. tin and one per cent. zinc, and coined at the rate of forty eight to the pound avordupois. The type of the obverse is the bust of the queen to the left and Britannia on the reverse, not unlike the type of the copper coins. In the sea surrounding Britannia are seen a lighthouse (said to be the old Eddystone) and a " windjammer " ; these symbols disappeared when the older portrait of Victoria replaced the young head in 1895 but the lighthouse has re-appeared on the new bronze coins of George VI.

It is difficult to believe that a penny, so insignificant in all outward appearances, should possess such an ancestry. Yet it can and, as we have seen, it does number among its " ancestors " truly aristocratic coins, such as the first silver pieces of all and the standard coin of the Mediterranean world. But what a great gap—one is almost tempted to say " chasm "—there is between the silver " Chelonai " of Ægina and the modest bronze pennies of Great Britain.

By Elizabeth Harvey.

A pleasant holiday-ground, as yet little visited by travellers from abroad, is here described. The illustration above of the fortified old town of Tallinn, capital of Estonia, gives some idea of the picturesque charm of this Baltic republic.

ALTHOUGH individually the English have always been adventurous travellers, statistically and in mass they are an unadventurous lot. Otherwise more of them would have discovered before this the charm and the cheapness of Estonia. And besides, since the English are the traditional champions of liberty they should admire the brave fight this little country has made after centuries of oppression to regain its freedom and the success with which that freedom is being consolidated into stability.

History has left a curious and interesting pattern on the country as it is to-day. Until 1918 Estonia suffered a fate that was consistently dark except for the century and a half under Swedish rule, a period which " afforded a brief breathing space in the course of suffocating centuries." First the Danish marauders came and the encampments from which the Estonians repulsed them are still to be seen cunningly set in the midst of marshy plains ; then in their great push northwards the Teutonic Knights reached Estonia and built fortified monasteries, churches, and the once impregnable castles perched on the top of mounds which are a pleasing feature of the Estonian landscape to-day. These Germans never left the country, but remained, a small oligarchy, exerting a feudalistic tyranny long after feudalism had passed away in the rest of Europe. Still to be seen are the magnificent manor houses in which they lived in the 18th and 19th centuries on estates which were sometimes as much as a hundred miles round. In the middle of the 16th century Estonia took an oath of allegiance to Sweden, but the German barons did not care for the many humanitarian reforms which were made to relieve the lot of the peasants, and in 1704 the young Charles XII of Sweden was conquered by the army of Peter the Great. The German barons and the new Russian overlords got on well together, but the Estonian people suffered greatly from the intensive Russification which followed and which forced the Russian religion, the Russian language, and conscription in the Russian army upon them. During the 18th century the horrors of serfdom in the strictest legal sense of that word fell upon them, and it seems strange that in that century of enlightenment and liberalism, when Horne Tooke was espousing the cause of the Americans and Johnson's Boswell was led to appear at the Stratford Jubilee in Corsican costume and with Paoli written across his hat, no champion came forward to help the oppressed people of Estonia.

In area Estonia is only 18,632 square miles but there is considerable variety in race, customs, and scene within its boundaries. The Estonian people belong to that curious Finno-Ugric group which includes the Finns and the Hungarians, and whose origin is still something of a mystery, but on the fringes of their country other racial characteristics predominate. In early times Estonia lay on the route the Vikings took to Byzantium and the country which later became Russia, and it is not surprising that Estonian folklore has much in common with Scandinavian ; the tomb of Truwor, one of the three Swedish brothers who laid the foundation of

Russia, is to be seen at Irboska on the eastern edge of the country. Estonian people, not unnaturally, look to the west rather than to the east for their historical background and their present inspiration and find it in their associations with Scandinavia. Certain islands off the coast of Estonia are inhabited entirely by Swedish-speaking people, who wear their national dress, keep their own customs and speak no Estonian though they are nationals of Estonia and always have been. Sweden finds them of very great ethnographical interest, but it has not yet been decided whether they came as settlers from Sweden at an early date or whether they are some independent offshoot. There are about 7,000 of them. Those living on the island of Vormsi wear a beautiful national costume which includes several pairs of hand-knitted stockings, for an ideal of womanly beauty in this district is to have legs looking as thick as possible, originating no doubt in the need for strength, for life is not easy on these rather barren islands.

Some Russian Characteristics

From the west to the east of Estonia is not far in actual distance but in passing from the one to the other you pass from one civilisation to another. As you approach the eastern border men with Russian blouses, cheerful, unshaven faces, and legs bound up in sacking tied with string begin to appear, and the villages suddenly and completely change their character. The wooden houses of the Estonian farmer or small-holder are usually built, with the barns and stables, on four sides of a square, and the whole is enclosed within a neat palisade, for Estonians like to live as far as possible from their neighbours. In the villages which came under Russian influence, however, the houses are placed close together in a line on both sides of the road, and sometimes these ribbon-development villages stretch for miles on end. Along the great Lake Peipus which separates Estonia from Russia the chief occupation is fishing, and in the daytime only very old men and young children are to be seen in the streets. The Estonians proper, and the Swedish-speaking population, are spick and span in their homes and persons and very reserved with strangers, but in this eastern district, though the houses are badly kept and broken down, the people are very gay and sociable, and ragged, bare-footed children rush up to the rare travellers who descend in their midst with hastily plucked bunches of wild flowers which they offer with charming smiles. They are taught the Estonian language in the schools.

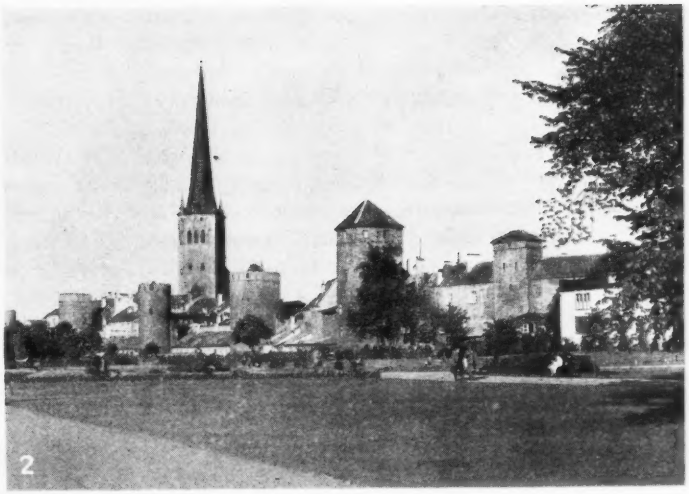
In 1918 the German baronial families were deprived of their estates ; in 1926 they were indemnified and those who remained in the country have mostly moved into the towns. It is characteristic of the fair-minded Estonian people that though they have no reason to love either their German or their Russian oppressors they cherish no feelings of revenge and accord their minorities all courtesy and freedom. As late as 1918 the Baltic barons or " balts " as they are always called, were planning to colonise Estonia with two and a half million small farmers from Germany ; at that time two-thirds of the whole country was held by about six hundred of these barons, who, not relishing the idea of losing their great estates, appealed to the Fatherland for help against the Bolsheviks. So that, when Estonia made her gallant fight for liberty, fighting one against ten and losing one in ten of her entire population, her enemies were both Germans and Bolsheviks. Europe at first sent help to the White Russian generals but later Great Britain became aware of the real situation and England was the first country to recognise Estonian independence on May 3rd, 1918.

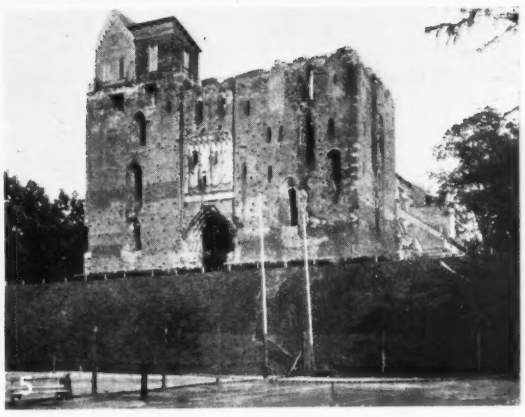
The way in which this re-established republic has faced its difficulties and set-backs is admirable. By living and working under the inspiration of a common ideal the Estonian people seem to be progressing steadily towards a promising future. No one is very rich and no one is very poor ; there are no great differences in income and yet the standard of dress and comfort is comparatively high. The krone is worth slightly more than a shilling, and an unskilled factory worker earns two krone a day, an important government official perhaps four pounds a week, star opera singers between six and ten pounds a month, and the President of the Republic not much more than £600 a year.

Few Language Restrictions

Small countries, with some justification, feel the need to raise nationalistic barriers for their protection. In neighbouring Baltic republics an official may not talk to a foreigner in the foreigner's own language until a stamp has been placed on the foreigner's passport to indicate that he does not reside in the country, but in Estonia an experimental method is used. For instance, the year before last the state decreed that all notices and announcements should be written in the Estonian language and in that only ; last year, however, the restriction was removed and at resorts where foreigners are likely to congregate information is often written in Estonian, Swedish, Russian, and German. There is a fairly general feeling of disapproval against the use of the German language, so long tyrannically enforced, but it is recognised as a necessity at the moment for outside contacts. English is now the first foreign language taught in the schools.

Building in the new state is going forward at a rapid pace and new hotels and blocks of flats are springing up





In Estonia : 1. *The modern Town Hall at Viljandi.* 2. *The rampart towers of Tallinn.* 3. *A lakeside hamlet.* 4. *The Russian Church at Tallinn, a relic of the old régime.* 5. *Tartu Cathedral ruins, which have been used as a library and as a water-tower, and are shortly to be restored.*

in the capital. Estonians feel slightly apologetic about the traces remaining in their country of the Russian régime, and the streets of wooden villas, built in a style which is rather too ambitious for the material used, and standing in deep shady gardens, are quickly being replaced ; the charming pontoon bridges which so often cross the rivers in the country districts are also disappearing. Every year the whole country is officially encouraged to share in some particular cultural aim ; last year Estonians were urged to beautify the countryside by painting their houses either yellow or " Swedish red " ; the year before was a book year, and before that a committee was set up to help people to change their names into an Estonian form. When the serfs were freed in the last century the high-handed Balts gave out names in an arbitrary manner so that people often found themselves with absurd names. Walter Scott was almost the only author read by the uncultured Balts and many Scottish names are to be found in Estonia. One man when asked what name he wanted replied : " I don't know," and this name he was given. In August of last year a Home Economics Chamber was set up, to give expert advice to housewives ; a feature of the organisation is to be a travelling exhibition which will penetrate into the remotest country districts.

A typical Estonian wayside inn.

Seen from the sea Estonia lies flat against the waterline except for a slight rise in the middle, on which stands Tallin, the country's mediæval capital, with its many churches. There is a dazzling splendour about a northern spring, perhaps because of its sudden completeness, and Tallinn in early June is unforgettably beautiful. From the harbour, filled with graceful wood-boats and white-sailed yachts, the visitor passes through the modern customs building (equipped for efficiency and comfort even to a café), and as he enters the ancient hill city through one of the narrow gates in the fortifications waves of scented greenness sweep towards him from limes and lilacs and from huge spreading chestnuts white with flower. Tallinn is a town of trees and grass and flowers and steep red roofs daubed at the edges with white, of tall houses rising narrowly from the thin cobbled streets. Its mediæval fortifications are in a state of preservation more complete than those of other European towns except Visby, in Sweden ; more than a kilometre of its town wall is standing as well as seventeen rampart-towers, four gate-towers, and two bastions. Three times it has changed its name, for in pre-Danish conquest times it was called Lindanissa ; Valdemar the Victorious of Denmark re-named it Reval, by which name it was known until 1918. Then the Estonians, feeling the need to obliterate associations with the unhappy past, chose to re-christen their capital Tallinn, which means a Danish castle, for the castle that Valdemar built is still a landmark of the city. Tallinn was built upon a giant's grave, upon a high mound of rock about a mile round. Estonia's national epic, the Kalevipoeg, relates how Linda, daughter of the great god Taara, married the giant Kalev and when he died buried him thirty ells below the sod, dressed in a silken shirt and a satin shroud bound with a silver girdle. Over his burial place she piled huge stones and immediately thick grass grew upon the mound, red flowers sprang from his cheeks, golden flowers from his eyelids, and harebells from his eyes. Certainly a special luxuriance still belongs to the soil of Tallinn whether the fabulous giant still lies beneath it or not. Aeroplanes from Finland and the west put down their passengers on a lake which lies above the town and is supposed to have been made by Linda's tears shed one day when she let fall a huge stone and could not lift it again. Legend says that a dwarf who lives in this lake emerges once a year to ask passers-by whether Tallinn is yet finished, and that if the answer is not always " No " the waters of the lake will overflow and flood the town.

Tallinn is in two parts, the old town, aloof and grand on its rock, and the newer part clustered below in the flat sandy plain. In the days of Estonia's subjection the healthy, pleasant upper town was sacrosanct to the families of the usurping Germans and Russians and no commoner was allowed to own property there or to walk on the path which ran along the scarp. But now the moat has been filled in and planted with grass and

flowers, providing a fine setting for the old town and drawing it into harmony with its once despised neighbour.

In the 13th century Tallinn was accorded the privileges of a Hanseatic town and relics of the rich burghers who flourished there for so long still remain. The four principal churches were all built before 1300 and the famous Town Hall before 1320. The Town Hall has been in continuous use since the day it was built but its treasures of stained glass, Gobelins tapestries and wealth of rich dark carving in high-relief dating from the 15th century, are soon to be preserved more carefully, for a new Town Hall for civic business is to be erected so that the old one may be kept as a museum. Tallinn's churches and the Black Heads' House are also full of mediæval treasures.

Tallinn is Estonia's biggest town but there are others, all interesting and strangely different from one another. Narva, on the extreme eastern border facing the Baltic, is a museum-piece baroque town built by the Swedes in the 17th century. Painted in rich pale colours, the burghers' houses, with their steep-pitched roofs and double rows of dormer windows and their beautiful painted ceilings and carved doorways, are still used as private dwelling houses. Narva has grown up on two sides of the river Narova and has been the scene of great conflicts between the east and the west. On the eastern side stands the great fortress called Ivangorod after Ivan III who built it, and on the western side the imposing but smaller Swedish fortress. It was here that during the Great Northern War the Swedes lost Estonia to the Russians under Peter the Great. Only five miles of barren no-man's-land, relieved here and there by an occasional farm-house, separates Narva from the closely guarded Soviet frontier.

A Linguistic Island

In the middle of Estonia is the university town of Tartu (formerly Dorpat), the headquarters of artists and literati. Here Professor Aavik makes his experiments with the Estonian language and adds new words which he forms on a curious system of sound analogies. The university was founded by Gustavus Adolphus. Petseri, in the south-east corner of Estonia, is a very remarkable town, for it is the centre of the Setu people, a strange isolated border group, which has a language of its own. Before 1918 these Setus had been exposed for centuries to Russian influence and because of their long cultural and linguistic isolation the assault of civilisation has been very slow in this district. Estonia is very rich in folk songs, and it is among the Setus that a very large proportion of this traditional music is found. Impromptu poems of astonishing length are made and recited by the old " song mothers " of the Petseri district on notable occasions ; they can recite thousands of verses from memory and are very highly thought of amongst their neighbours for this accomplishment. The little town of Petseri is a local metropolis but its peculiar wooden architecture is swiftly disappearing before more modern buildings.

Radio-active mud is found in large quantities on the Estonian coasts and this has given rise to many health resorts where cures may be taken in up-to-date style at incredibly low fees. Hapsalu is a charming old town with an ancient, haunted castle, while Parnu, with its miles of fine white sand, has more sophisticated delights to offer ; here a large modern hotel is being built on the sea front, no room in which is to cost more than three shillings a day. The duties of the mayors of these spa towns include mixing with the visitors, seeing that they are happy, and introducing them to one another.

Estonian Landscape

In the north of Estonia the country is somewhat bare and flat, with small scrub-like trees, and only here and there a modest wooden farmstead ; in the west there are peat-bogs and windmills, but in the south the country is rich and undulating with deep forests of pine and fir through which the road winds crazily, for Estonian roads, they say, were made by horses browsing at will while their drivers slept in their carts. Sometimes the scene has a breadth and contour not unlike our own Cotswolds, and sometimes it breaks into a combination of lakes, firs and slopes reminiscent of a miniature Switzerland. Viljandi (the word means the grain-givers) is in the midst of this productive southern district, and is a well-planned town, with the remains of a castle built in the middle ages by the Livonian bishops and still surrounded by a triple, once impregnable, moat ; one of the most beautiful views in Estonia is that from the rampart down upon the wide river curving at its foot and away into the fertile landscape beyond. Scenic wonders and spectacular heights are not to be expected in a country whose highest hill is only 1,066 feet high, but there is great charm in the wide free views over ploughland and lake, and stimulation in those dark eastern forests where bears are still to be found.

Estonia has had her political troubles, and Mr. Constantine Päts, the President of the Republic, at present holds full powers, a temporary measure which will continue until a constitution suited to the people can be formed. In external politics the government has some cause to fear Estonia's position between Russia and Germany ; in internal affairs there would seem to be everything in favour of peace, prosperity, and progress.

An Ill-Starred Jungle Railway

By R. G. Mingay

This article by one who has lived for many years in Brazil describes the forty years of striving which led to the construction of a two-hundred-mile line, now practically derelict.

In my motley collection of books, picked up in odd places, is an imperial octavo volume, gilt-edged and leather-bound, published by order of the Emperor of Brazil in 1885. It is the report of the Commission sent by the Imperial Government to survey the route for the Madeira-Mamoré Railway, after two disastrous attempts had been made to build the line. It contains maps used by the expedition, marked by hand in red ink, and numerous photographic prints, which have been gummed on pages left blank for the purpose. The original intention was to cut a channel through the rock of the falls between Porto Velho, on the Madeira River, and Guajará-mirim, on the Rio Mamoré. The Mamoré rises near Cochabamba, on the Central Plateau of Bolivia, flows down to the Brazilian frontier, where it is joined by the Guaporé, and continues north, forming the border of the State of Matto Grosso, until it reaches the Beni River. The latter also has its source in the Bolivian Highlands and, on its way across the continent, mingles its waters with those of the Madre de Dios, from the Peruvian Andes. The Madeira River is formed by the confluence of the Mamoré and the Beni, fifteen hundred miles from the former's source, and these two flow together for another two thousand four hundred miles through the State of Amazonas to join the mighty Amazon.

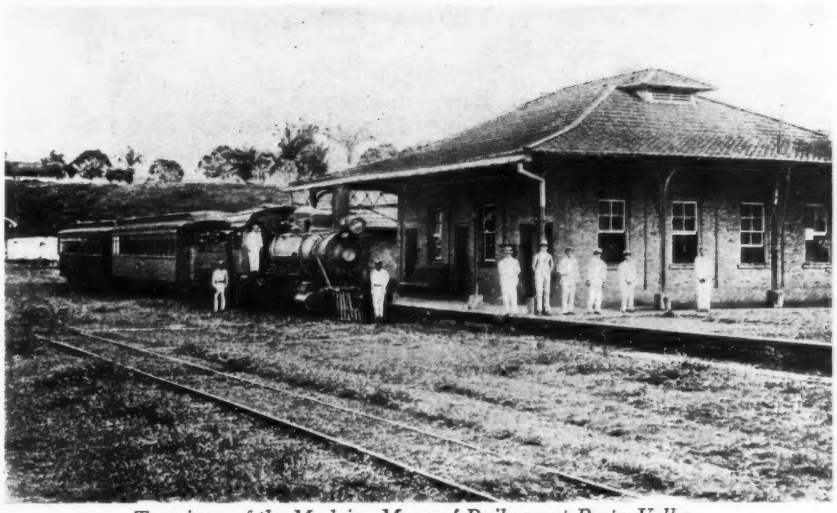
All these waterways are navigable throughout the greater part of their length, but between Porto Velho, in Amazonas, and Guajará-mirim, in Matto Grosso, a series of ten large falls interrupts navigation over a distance of two hundred miles. The Brazilian rubber gatherers in the north of Matto Grosso, and their Bolivian colleagues on the banks of the Beni and Mamoré, exporting their produce via the Amazon River, were obliged frequently to load and unload the canoes over this stretch, carrying boats and cargo through almost impenetrable forest, infested by disease and hostile Indians. The journey of two hundred miles occupied forty days and is reputed to have cost over forty thousand lives during the rubber boom.

To give the traders an uninterrupted passage to the sea, a Bolivian political refugee, General Quevedo, conceived the idea of cutting a channel through the rocks. With this object the National Bolivian Navigation Company was formed in London by Colonel Church in 1867. The scheme was soon afterwards recognised as impracticable and was abandoned in favour of a railway, which the same company undertook to construct with the funds subscribed for channelling. With little knowledge of the locality and its conditions, they started work in 1872 and met at once with almost incredible difficulties. The most elementary necessities had to be brought by water for thousands of miles in primitive native craft. Supplies were often wrecked or stolen. Malaria and beriberi decimated the encampments and Indians repeatedly raided them. The constructors struggled on for twelve months, making little progress, before abandoning the work.

Clearing the way for the track near the Samuel Falls.

Two other firms attempted, in turn, to continue the

line, but in 1878 the shareholders of the National Bolivian Navigation Company, who had not consented to the transfer of capital to the Madeira-Mamoré Railway Company, won their action in the London courts and the company was wound up. The Brazilian Government then took up the project and sent a commission of engineers to survey the route in 1883. The party, numbering sixteen, was accompanied by a military officer and twenty-five soldiers, and took with them a naval lieutenant and nine men to man the boats. They pitched their camp above the Santo Antonio Falls, the most northerly of the series, and drove the first stake for the survey on March 19th, 1883.



Terminus of the Madeira-Mamoré Railway at Porto Velho.

Thereafter the Chief Engineer's report, in the form of a diary, is a record of disasters, interspersed with instructive comments on the geology of the region and the conditions of the local rubber trade. Within two months of landing only five of the original members of the commission remained to carry on the work. The remainder, and the greater part of the military and naval detachments, had died or been invalided to Manaos. Intermittent fevers caused paralysis of the legs and later of the whole body. Scurvy broke out owing to the lack of fresh meat and vegetables, and to the deterioration of other food supplies. Day and night, without a moment's intermission, mosquitoes and sandflies tormented them, driving them to despair. Boats were wrecked and valuable stores lost. Work was constantly interrupted to rush sick men to the nearest civilised settlement.

Still the expedition moved forward, reinforced from time to time by new arrivals. Plunging deeper into the jungle they came occasionally to a shack, raised high on piles, where a rubber trader, with his family, maintained a precarious existence year after year, alone in a hostile wilderness. Peaceful Indians, men and women, were constrained by fear to work for him, receiving small wages and purchasing their supplies from him at high rates, so that they remained always in his debt. Attempts to escape were ruthlessly punished. In the surrounding hordes of savages he instilled respect by a liberal use of firearms whenever they approached too near. No man of softer fibre could have endured there for a month.

The expedition advanced by water wherever possible, threading their way through narrow passages in the rock when the depth of water allowed. The various falls measure from ten to forty feet in height and from four hundred to a thousand yards in width. They are formed of projecting masses of granitic rock, in single ledges or a succession of shelves, split by contraction into thick slabs and great rounded blocks, and covered by a dark, vitreous layer. The depth of water in the channels between the rocks was often insufficient for the shallow canoes. The boats had then to be dragged ashore and rolled for long distances on branches lopped from the trees. Clearings and trails had to be cut whenever they landed, as the forest rose like a wall from the water's edge—giant trees, with interlaced boughs, emerging from impenetrable undergrowth and roped together with snake-like creepers. Frequently the sailors could make no headway against the strong currents, or they were drawn into the rapids and overturned. Torrential rains scourged and chilled them, and for many days their sole food consisted of a handful of flour.

Under date of July 17th there is a brief entry in the Engineer's diary: "Nine more sick men to-day." On the following day another engineer collapsed, and three men were brought back to camp, trembling with ague. By July 31st thirty-five men were laid low, and on August 15th, when it was decided to withdraw the commission, no man remained on his feet to pack the instruments and stores.

Another expedition set out in the following year

under the same leader. Better equipped and organised, it completed the survey, but with a further heavy loss of life. A third attempt to build the line was then made. Like its predecessors it ended in disaster, and when a relief party arrived to take away the staff only one man was found alive. Many had died of beri-beri, malaria or smallpox. Others had been killed by Indians, who lay in waiting for weeks around the camp until their victims were sufficiently weakened to facilitate attack. The survivor, the storekeeper, attributed his salvation to the fact that an epidemic broke out among the savages after they had stolen the clothes of a smallpox victim. It was ascribed to the vengeance of the white man's gods, and thenceforth the camp and its solitary occupant were given a wide berth.

One Train a Week

Finally, in 1905, under the Treaty of Petropolis, which put an end to the territorial disputes between Bolivia and Brazil, the latter assumed an undertaking to complete the railway. Its construction was entrusted to a firm of American contractors, who began work in 1908. Well organised and amply provided with funds and imported labour, they started by blowing up parts of the falls, where basin-like formations assisted the breeding of mosquitoes. They erected insect-proof houses for the workmen and up-to-date hospitals, manned by skilled doctors and trained nurses. Even so, more than fourteen hundred lives were lost during the course of the work, which lasted four years. The first section was opened for traffic in 1910, the second in 1911, and the final sleeper was laid in April, 1912. A period of activity followed, during which the progress of this unhealthy, desolate region seemed assured. Small groups of palm-leaf shacks grew into villages and towns. Other settlements appeared alongside the track, together with fields of maize. But prosperity was short-lived. When the rubber boom collapsed the population drifted away. Deserted villages were invaded by the forest, which ruthlessly effaced all traces of former habitation. Struggling against increasing financial losses the operating company managed to maintain its services for twenty years of dwindling trade and gradually increasing depopulation. At last, in 1932, the Brazilian Government took over the railway and kept it running in a forlorn attempt to save the district. A train still leaves Porto Velho at seven o'clock each Wednesday morning, and arrives at Guajará-mirim, two hundred and twenty miles distant, at two o'clock on the following afternoon. But the line which cost so many thousands of lives, and filled the streets of Manaos with cripples, is practically derelict. In the words of the latest Brazilian geography it is "of little service to the State."

Synthetic Gemstones

By R. W. H.

Modern science has discovered methods for reproducing gemstones. Several stones still elude the chemist, but purchasers of "bargains" in gems should be wary.

For many years, behind the walls of dingy laboratories unknown to the world at large, chemists have been endeavouring to build up, or synthetically produce, precious stones. Man strives to evolve in a few hours what in nature is the final product of a creative force of thousands of years' duration. It is not surprising, therefore, to find that these efforts have met with indifferent success.

At the present time the only gemstones that have been manufactured in commercial quantities are the ruby and sapphire and the lesser known spinel. Many others have been formed in recognisable pieces, but it is one thing to produce a stone, and quite another to manufacture it in pieces large or transparent enough for cutting, thus allowing it to compete with the hardly-won natural gem.

It would at first appear that the simpler the composition of a substance, the greater the ease with which it might be formed. The diamond, however, which is pure crystallised carbon and has by far the simplest formation of all gemstones, has defied all efforts at its production in sizes or quantities of any consequence. The pressure and temperature necessary to convert the black amorphous carbon, or charcoal, into the beautiful crystallised variety so highly valued, have never been attained, and the result of many attempts has been a few microscopic and badly formed crystals.

Diamond Making

The first experiments in diamond formation were carried out in 1880 by J. B. Hannay, a Glasgow chemist, who heated for several hours in a furnace a mixture of lithium, bone oil, and paraffin contained in a stout iron tube. Of eighty experiments only three were successful in producing minute crystals. The rest failed owing to the bursting of the tube under the enormous pressure.

In 1893 the French chemist Moissan attempted diamond manufacture by placing a mixture of pure iron and pure carbon in a crucible, and subjecting it to a heat of 4000° C. in an electric furnace. The crucible and its contents were then plunged into water and rapidly cooled. Some small crystals were obtained, the largest of which was but .7 mm. in length.

From time to time efforts have been made to place

"synthetic diamonds" on the market. One notable occasion was during February, 1935, when certain speculators almost persuaded a credulous public that the impossible had been achieved. The so-called "synthetic diamonds," however, were subjected to the rigid tests of the Gem Section of the London Chamber of Commerce Laboratories, and the result proved these stones undoubtedly to be synthetic spinels.

As rubies and sapphires have always commanded good prices, the question of their production by artificial means has more than academic interest, and it is with regard to these that man has achieved his greatest success in imitating the processes of nature.

Reconstructed Rubies

Early attempts began in 1837, when the French chemist Gaudin produced a few tiny flakes, and later, in 1877, Frémy and Feil succeeded in manufacturing larger plates of ruby. It was in 1885, however, that the gem market received a rude shock when a number of apparently perfect rubies were exhibited at Geneva. They had all the physical characteristics of genuine rubies and were sold at high prices. The secret of their manufacture was well kept, but, eventually, it seemed certain that they were made by fusing a number of smaller rubies in the oxy-hydrogen blowpipe, and letting the mass so obtained cool and crystallise out. This process, now known as reconstruction, was applied with some success until 1904, when Verneuil, who was a pupil of Frémy, invented his ingenious blow-pipe, thus establishing a method of synthesis which, with certain improvements, enables the present-day chemist to turn out large masses of flawless corundum, particularly ruby and sapphire.

The process consists of the introduction of alumina powder into the upper part of an inverted blowpipe through which a current of oxygen and coal gas passes. As the powder falls and comes into contact with the flame at the orifice, it exudes as a liquid drop. The drop is carefully controlled by an adjustable platinum sleeve, which can be lowered as the drop increases in size. The drop, or *boule*, as it is called, grows in the shape of a pear until of the maximum size, when the gases are suddenly cut off. Present-day improvements have so perfected this process, that one man can attend to a dozen such machines.

If no colour be added to the alumina powder, a colourless stone known as synthetic white sapphire is formed. Ruby red colour is furnished by the addition of chrome alum to the powder, resulting in the synthetic ruby. By reducing the amount of chrome alum, pink stones are formed. For blue stones, or synthetic sapphires, a small quantity of titanium oxide is added, while for yellow and yellow-green a little nickel oxide and vanadium oxide has the necessary effect.

Spinel, whose colours are blue and red, is another beautiful gem which can now be manufactured on a commercial scale. During the last ten years many of these stones have been made, especially in colours to imitate aquamarine and blue zircon. The synthetic white spinel came into prominence in connection with the "synthetic diamond" scare of 1935.

Like the diamond, the synthesis of emerald has eluded chemists and scientists. Last year, however, two eminent German scientists attached to the great chemical concern, the I.G. Farbenindustrie, synthetically produced an emerald of comparatively large size and excellent lustre. This discovery will, no doubt, pave the way for further developments in the field of synthetic emeralds, but at the moment the process is laborious and expensive and it may be some time before the synthetic emerald can compete with its natural fellow.

Tell-tale Bubbles

Synthetic gems are identical in all respects to the natural stones of their species, with the exception of their so-called zone structure. This zone structure is easily discernible through a powerful eyeglass or microscope, and sometimes even to the naked eye. The comparatively rapid cooling of the synthetic mass in the laboratory has a sagging effect on the interior construction of the stone, resulting in curved lines or striations and small round air bubbles. Above all things, most natural crystals of precious minerals form relatively slowly, their constituent atoms having time to arrange themselves uniformly. It is, therefore, found that natural gems show straight lines in their interior construction, which may or may not intersect one another at angles varying with the type of stone. Any inclusions, such as gaseous bubbles, are invariably angular in form.

The advent of the perfected synthetic ruby and sapphire facilitates the substitution of the fraudulent for the real, and it behoves tourists visiting places in the East to be careful from whom they buy. In Colombo especially, the visitor is frequently accosted by "touts" who produce glittering trays of seemingly perfect stones, but when one considers that thousands of synthetic stones are exported to the East every year, it is well to be wary of remarkable bargains.

The Council of the Physical Society has awarded the fourteenth Duddell Medal to Walter G. Cady, Professor of Physics at the Wesleyan University, Middleton, Connecticut, U.S.A., for his work on piezo-electric resonators and oscillators as standards of frequency. The presentation was made at the Society's meeting at the Imperial College of Science and Technology, South Kensington, on July 9th.

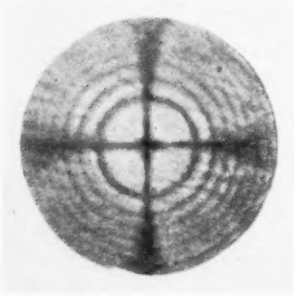
The Optical Determination of Stress

By C. G. James.

The extremely useful optical stress analytical methods, which are gradually becoming more widely used, enable engineers to see visually, or record photographically, stressed areas in various structures by passing a beam of plane-polarised light through a model of the intended structure.

THE construction of a bridge may be contemplated but, owing to local conditions introducing design complexities, it may not be possible to ascertain exactly where it is necessary to strengthen the bridge to withstand certain conditions. Optical stress analysis actually shows the stressed areas in a structure if the model is loaded in a manner similar to the full-size structure. An example is shown in the photograph of the model of the simple single-span bridge which was loaded at the centre of the span. In some cases the actual stresses may be computed by the colour of the light in the stressed areas. From this it will be realised how important is the method. Dubious mathematical calculations can be checked or others verified with a great saving of time, and also what is more important, an increase in the safety factor.

The principle upon which the method is founded is not new, for Sir David Brewster, one hundred and twenty years ago (Phil. Trans., 1816), demonstrated that a homogeneous isotropic transparent substance like glass, when subject to stress, takes on crystalline optical properties such as that of rotating a beam of plane-polarised light, or conversely of plane-polarising ordinary light, properties which it does not possess when in the normal unstressed condition. Clerk Maxwell also showed that a jelly such as isinglass jelly possessed this property (Collected Papers, Vol. I). Latterly, Professor E. G. Coker has shown that celluloid is yet another substance which normally is isotropic but when stress is induced doubly refracts in the same manner as a crystal.



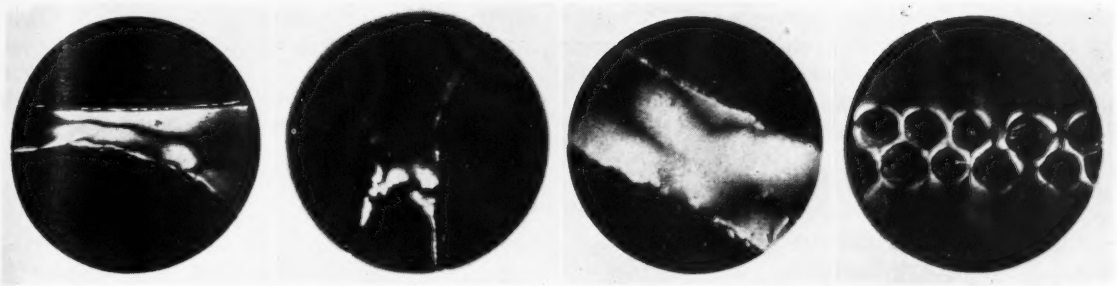
Rings and brushes in a quartz crystal plate.

Before discussing the wide and varied applications of photo-elasticity and the results obtainable, it will be of interest to examine what is meant by crystalline optical properties. Now the peculiar optical properties possessed by some crystals were studied by many of the early crystallographic investigators. The phenomena of double refraction, polarisation, interference fringes and other allied effects observed when a beam of light is transmitted through crystals belonging to crystal systems other than the cubic, have been well known for many years. One of the best known of these effects is that of double refraction and the consequent polarisation of light. If a beam of common light is passed through a Nicol prism (which is two portions of a rhomb of Iceland spar cemented together with Canada balsam) the light is split up into two beams, one of which is absorbed, while the beam that is transmitted is found, on emergence from the prism, to be plane-polarised.

Common light possesses a transverse wave motion; its vibrations are in every plane at right angles to the direction of propagation. A plane-polarised beam has its vibrations confined to one plane only. This can be verified very simply, for if a second Nicol prism be placed in the path of the transmitted polarised beam and this prism is then rotated with the first prism fixed, it will be found that at every 90° point of the 360° rotation of the second prism there will be a black field. At 45° positions the field will be bright. When the prisms are at 90° to one another they are said to be crossed. The first prism is termed the polariser—it polarises common light; the second prism is called the analyser—it determines whether a beam is polarised. A plate cut from tourmaline may also be used in this connection.

If, with the Nicols crossed, a crystalline plate be placed between them it will be noticed that, generally speaking, the light is restored, and in further cases the light is brilliantly coloured. A crystal plate consisting of a plane section cut from an uniaxial crystal—a crystal which has but one optic axis—is especially interesting, for if this plate be examined with a suitable lens system between crossed Nicols, and convergent polarised light is used, remarkable rings and brushes make their appearance like those shown in the photograph. The plate under examination must be so cut from the crystal that the optic axis is normal to the plate, that is, in the direction of the transmitted light. A biaxial crystal would show two series of rings.

The photograph does not show the colours, but in reality the rings are coloured and the dark cross or brushes are dark. When the Nicols are rotated together while still remaining crossed with the crystal plate stationary, the brushes rotate with the Nicols; the



Stress photographs: Left to right; a model of a simple single-span bridge loaded at the centre of the span; a fractured test specimen; stresses in a beam under tension and torsion; and stress accumulation around a series of holes in a tension plate.

coloured rings remain unchanged. These interesting rings and brushes are due to the polarised beam that is transmitted by the first Nicol being split up into two wave fronts, being again doubly refracted in fact, by the arrangement of the atomic and molecular layers in the plate. One system of waves being retarded in respect to the other, they do not recombine in phase on emergence from the crystal plate surface and the two wave fronts, therefore, interfere with each other on emergence. Where a crest meets a trough the result is cancellation. That area is dark. Where two crests meet or two troughs meet reinforcement of the light takes place. The coloured rings and the dark brushes are the results of this interference.

Similar phenomena happen when a stressed transparent isotropic material is placed between crossed Nicols. When stress is present, the substance, either by depolarisation of the light or by double refraction which breaks up the light into two wave fronts like the crystal plate already described, has acquired some of the optical properties of a crystal and the interference of the two wave fronts shows the characteristic coloured bands and dark brushes. If no stress is present, or the principal stresses are the same, the area is dark, for the polarised light from the polarising Nicol which is transmitted through the unstressed portion is completely extinguished by the analysing Nicol.

Without going into somewhat difficult wave mechanics, the reason for these effects in transparent isotropic substances is that light being a wave motion, its velocity through any transparent substance is directly proportional to the square root of the ratio of the elasticity to the density of the material through which the wave is travelling. From this it can be readily understood that when a model is loaded so that stress is induced, the ratio of the elasticity to the density changes. The speed of the two wave fronts not being the same, interference effects are produced. Dark lines, called isoclinic lines, may be the locus points of principal stresses, for stresses can generally be resolved into two directions at right angles to one another. Where this happens the principal stress axes may be determined by rotating the Nicols together. If the lines are caused by stress they move, but the coloured bands do not rotate. Dark areas at which there is no stress obviously do not move, for at these points the substance is optically inert and does not depolarise the light.

It has been mentioned that the amount of stress can be ascertained by the appearance of the colours in the coloured (isochromatic) bands. This can be done by loading a standard specimen of definite size with a known load. Such a standard specimen may be a rectangular piece under simple tension. The stress in such a simple specimen may be readily calculated against various loads, and the colours therefrom obtained matched against those of a complex specimen where bands of colours are present. The presence of two very different coloured bands close together shows that a high stress difference exists at these points. High stress differences at adjacent points are danger areas, for failure in a structure is often caused by this.

However, quite simple specimens can be full of interest, as the illustrations show. In the specimen which has just begun to fracture the stress is greatest at the portion which has not yet fractured, which is as it should be judging by purely theoretical reasons alone. High colour values were present at this point although the photograph does not show these. The residual stress at the already fractured ends can be seen, but these areas were white. On the whole the method is also valuable for demonstrating the effect of shape on stress concentration. In the photograph of the stressed area in a beam under tension and torsion the appearance amply confirms theoretical assumptions of where the areas of stress should be. The interesting photograph of a plate with holes shows how stress accumulates around a series of holes in a tension plate.

Many and varied are the applications to which

optical stress analytical methods may be placed. In America, where the manufacture of stressed skin monocoque fuselages for aircraft has been brought to a fine art, the method is being used for mapping the stress in models of fuselages and wings. Both cut-outs and actual models have been used, but the difficulty with the latter is in obtaining the model in a state of quiescence before the loads are applied. Even in the case of cut-outs it is necessary to focus on the interior of the substance as the " skin " of celluloid is sometimes in a condition of stress due to the manufacturing process. While experiments made by the author tend to show that most of the new transparent synthetic resinous materials are not suitable for optical stress experiments as, here again, high internal stress is often encountered without external load being applied, other improved manufacturing methods for the models may obviate this.

Shakespeare and the Post Horses

By Professor R. B. Mowat.

Shakespeare was not above including topical political allusions in his plays; and here Professor Mowat discusses an incident in "The Merry Wives of Windsor," which till now has not been satisfactorily accounted for.

> In Act IV, scene iii, of *The Merry Wives*, Shakespeare suddenly alters the whole background of the play in order to introduce what is evidently an allusion to some recent posting scandal. Up to that point we have had before us the ordinary routine of a not very busy country inn, with a solitary tapster drawing the drinks, a garrulous host who is anxious to secure more custom, and a guest from town occupying what is evidently the best chamber and running up bills for himself and his three servants to the tune of ten pounds a week . . . Suddenly, in this short scene, we are asked to believe that the inn before us has been " at command " of certain Germans for a whole week, and that the host has been obliged to " turn away " his other guests.

In this paragraph Professor Crofts states a problem which has troubled Shakespearean scholars for over a hundred years. In the short scene iii of Act IV, the Germans arrive at the inn, hire the host's horses, ride off to meet their master, a " Duke of Jarmany," pitch their guide, Bardolph, into a slough beyond Eton, and disappear from the play. After this the play proceeds to its conclusion as if the incident had never happened.

> It is plainly an excrescence on the plot, only explicable as allusive, and affording, therefore, strong presumptive evidence that at the time when Shakespeare was writing somebody was known to have stolen some post horses.

In 1840 Charles Knight identified the Duke of Germany, whose servants stole the post horses, with a certain Count Mompellgart, a visitor to England in 1592. This identification, for which there is no evidence except the words *cosen garmombles* (" Cousin Mompellgart ") in the Quarto edition of *The Merry Wives*, has been almost universally accepted ever since Knight made it. Yet there is every reason to consider it an unjustified libel upon Mompellgart, about whose visit to England the facts are quite well known from the narrative of his secretary. Mompellgart was never in any trouble about horses in England. Besides, his visit took place in 1592. The accepted date for the writing of *The Merry Wives* is now 1597 or 1598. There would be no point in Shakespeare dragging into a play of 1597 or 1598 a mysterious allusion to some trifling incident of five years earlier. No Elizabethan audience would have had any idea what the allusion was about.

There was, however, a recent scandal about a distinguished foreign traveller and post horses. This occurred on September 4th, 1596, when the Sieur Aymer de Chastes, Governor of Dieppe, after fulfilling a diplomatic mission in England, was returning home by way of Gravesend. He had a warrant issued by the Crown, which ordered the postmasters to provide him with horses for himself and his retinue. Finding that the postmaster at Gravesend had not sufficient available horses, de Chastes made his servants break open the stable door and seize two horses belonging to private travellers. Professor Crofts does not think this to be the incident referred to in *The Merry Wives;* but he does, reasonably, contend that it gives a date before which the incident of *The Merry Wives* could not have occurred. " It is incredible that theatregoers of 1597, searching their memories for the originals of three German horse-thieves, would have been able to pass over this recent and notorious exploit by three French ones—for that is how de Chastes and his two servants might have been described." There was, however, another much talked-of post-horse scandal which occurred at Chard in 1597.

The Elizabethan Government had postmasters (usually innkeepers) at fixed stations along the main roads. The postmasters were bound by contract to serve the Queen's warrants at the special rate of 1½d. a mile and to keep horses ready for the purpose. Travellers who had no Royal Warrant would have to make their own arrangements with the postmaster who usually carried on a jobbing business of his own and would charge at least 2d. a mile.

On November 17th, 1597, a certain John Howard

presented at Chard a post-warrant issued by Lord Thomas Howard and Lord Mountjoy. Chard was not a regular post-station, but genuine post-warrants were often presented at places where no post-stage had been laid, and the local bailiff was bound to honour them. For this purpose he would take up by compulsion from private people horses at the Government rate. Now, John Howard's warrant was an impudent hoax, for the Lords Thomas Howard and Mountjoy had no right to issue warrants on behalf of the Crown. Official post-masters kept a list of the persons authorised to issue warrants. This explains why John Howard did not present his bogus warrant at a regular post-stage, for instance, at Plymouth or Crewkerne, but at the intermediate town of Chard. The fraud was successful. The Bailiff of Chard took up two horses, one belonging to a certain Richard Godden, who was also appointed to guide Howard. Naturally, Howard meant to avoid the next post-stage, which was Crewkerne, and to try his warrant again on the bailiff of some other country town between Crewkerne and Shaftesbury, perhaps at Yeovil, "thus continuing his posting leap-frog towards London at a cheap rate." His guide, however, who was not in the plot, probably disputed with him about the post-stages; and in the end John Howard severely beat the guide and rode off with the horses. The guide brought an action for damages in the Court of Common Pleas against the bailiff and constable of Chard and thus the whole affair became public. It was probably settled by the Privy Council ordering Lords Thomas Howard and Mountjoy to compensate the parties whose horses were taken.

A Court Intrigue

This incident, if introduced in a play of 1597 or 1598, even if the affair were guardedly ascribed to "three Cozen-Jermans," would be easily understood by any Elizabethan audience. Critics, however, may legitimately ask why Shakespeare should wish to introduce the incident. There is a sufficient answer to this. In 1597 there was a quarrel between the Lord Admiral Charles Howard (cousin of Lord Thomas who issued the bogus warrant) and the Earl of Essex. It was a serious quarrel because the question at issue involved the honour of Essex. The Queen had made Lord Admiral Charles Howard an earl, and in the patent of nobility had seemed to ascribe to him all the glory of the Cadiz Expedition of 1596. Essex, who had been one of the leaders, and a valiant successful leader, of the Cadiz Expedition, naturally resented the ascription of all the glory to Howard. He resented this all the more because he had just returned from his very unsuccessful "Islands" Expedition, which he believed to have been a failure largely owing to the jealousy of courtiers. Now, Shakespeare was an "Essex" man, or at any rate was a man of the Earl of Southampton who was a friend of Essex. The incident of the post horses could, accordingly, be introduced into *The Merry Wives* in order to make the audience laugh knowingly about the Howards and show sympathy for the Earl of Essex. But why are the horse-thieves called Cozen-Jermans? Here again there is a simple answer. The Howards were cousins-German of the Queen. The "three Cozen-Jermans" would be identified in the minds of the audience as Lords Charles and Thomas Howard and Lord Mountjoy. It is true that Mountjoy was not a Howard, but this fact is no particular difficulty in including him in the disguised allusion to three Cozen-Jermans.

Offence in High Places

A more serious difficulty is the question where a play containing a satire on powerful court personages could be performed. It could scarcely have been safely performed publicly in 1598. Professor Crofts suggests that it was privately performed on February 12th, 1598, at Essex House. It is known from the Sidney Papers that on this day a great supper was given at Essex House and that two plays were performed "up till 1 a Clocke after Midnight." One of those two plays may well have been *The Merry Wives of Windsor* with the post horses incident. Something seems to have happened in the play-acting on February 12th at Essex House to have offended highly-placed personages, for, on February 19th, the Privy Council decreed that one of the three London companies of players be suppressed. Professor Crofts sums up his view as follows:

> These suggestions are all purely conjectural, and those relating to the performance at Essex House may be thought wantonly so. But they serve at least to show that an interpretation of the horse-stealing scenes in *The Merry Wives* as a satire on the Howards is not necessarily inconsistent with such facts as are known concerning the Elizabethan court and stage; and I venture to submit that it rests on a much firmer basis of probability than the Mompellgart myth. Here, at least, is a posting scandal which did occur, which involved eminent men, and coincided with a political contest in which the sympathies of Shakespeare's patron must have been hotly engaged; here is the occasion when a scene alluding to this contest could have been performed with every prospect of good acceptance; and here, finally, are the consequences which, if it was performed, we might, in the circumstances expect.

Professor Crofts's book* does not by any means deal only with the post horses incident of *The Merry Wives*. Beginning with this, he has gradually constructed a complete theory of the play; its date, composition, history and staging. A discussion of all this, however, would go far beyond the limits of the present article. Everyone interested in the fascinating study of Shakespearean drama is recommended to go to the book shelf.

* J. CROFTS, *Shakespeare and the Post Horses*. (University of Bristol Studies, 1937. J. W. Arrowsmith, Ltd.).

A Rubber Plantation in a Laboratory

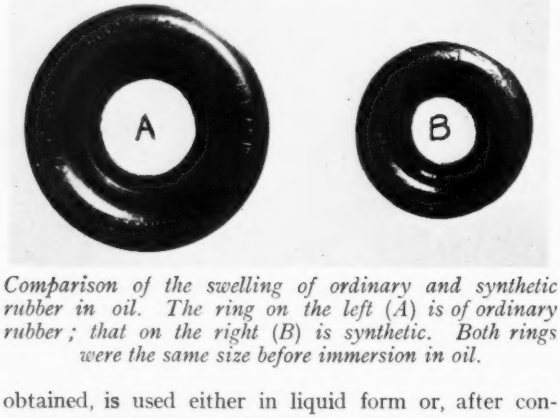
By T. L. Garner, M.Sc., A.M.I.Chem.E., F.I.R.I.

It is usual to regard synthetic rubber as a competitor of natural rubber. Recent research, however, has shown that the synthetic material has well-defined advantages and disadvantages which put it in a class by itself, suitable for certain special applications.

THERE is a feeling, largely unwarranted, that most of the important discoveries and inventions arise from chance observations. Like most part truths, this ignores the keenness of the investigator to see the possibility of his observations and his toil before the germ of a new idea develops into a mature proposition.

The commercial development of successful types of synthetic rubber is comparatively recent, and the first to be produced in America originated as a result of experiments carried out by a chemist in the meat packing industry. Dr. J. C. Patrick was experimenting in the early nineteen-twenties to produce cheaper anti-freeze chemicals, and he mixed together ethylene dichloride and sodium polysulphide, expecting a new liquid anti-freeze to be formed. Instead, a gummy mass resulted, which looked and felt like rubber. More than a decade of hard work was necessary, however, to bring a process to perfection for the preparation of the new material, which can replace rubber and in many ways improve upon it.

Latex, the produce of the tree *Hevea brasiliensis*, from which 98 per cent. of the world's rubber supply is



Comparison of the swelling of ordinary and synthetic rubber in oil. The ring on the left (A) is of ordinary rubber; that on the right (B) is synthetic. Both rings were the same size before immersion in oil.

obtained, is used either in liquid form or, after conversion to solid raw rubber by removing the water, for a wide variety of commerical products. For many of these, despite the research which has been carried out in its application, it is not ideal, but it represents the best natural product available for the purpose. The art of compounding rubber with various other materials to bring out desired properties, and to ensure longer life, has developed rapidly, but there are obvious undesirable properties of raw rubber which cannot be entirely masked.

Rubber is still subject to deterioration by oxidation, although this can be delayed considerably by skilful compounding; repeated application of forces which distort its shape results in a fatigue failure revealed by the development of cracks in the rubber. Despite the improvement in the mileage which modern tyre treads will run before wearing out, it has not been possible to produce a tyre which will last the life of the car. Finally, natural rubber in its best compounded forms has only a limited resistance to many chemicals and particularly animal, vegetable, and mineral oils. In addition to these particular points of weakness, raw rubber is subject to variations common to natural vegetable products. Rhodes of the Rubber Research Institute of Malaya sums this up as follows:—"Latex is not and can never be a synthetic laboratory chemical of constant composition. It is a biological fluid, and not a special chemical. It comes from a tree which is dependent for its very existence on sun, rain, and the soil. Because the tree is a tree, it is subject to natural physiological cycles of wintering, refoliating, flowering, and seeding. Rubber trees differ slightly in genetic strain. They grow differently on different soils, and it is ridiculous for us to expect to obtain latex of the same chemical composition all the year round. The factors which affect variation in latex are: (1) the season of the year, (2) the age of the trees, (3) the geographical situation, (4) the state of the soil, and (5) the genetic strain; these variations are of the sort which cannot be prevented by any known means."

While rubber growers can do something to maintain a reasonably uniform product, therefore, they can never attain the uniformity of a synthetic chemical product. The desire for a synthetic rubber consequently arises from the need for an improved commercial material. Coupled with this, however, is the attitude of Germany and Soviet Russia that at any cost they must be in a position to supply all essential raw materials. These two countries, with America, have been responsible for the present methods of producing synthetic rubbers.

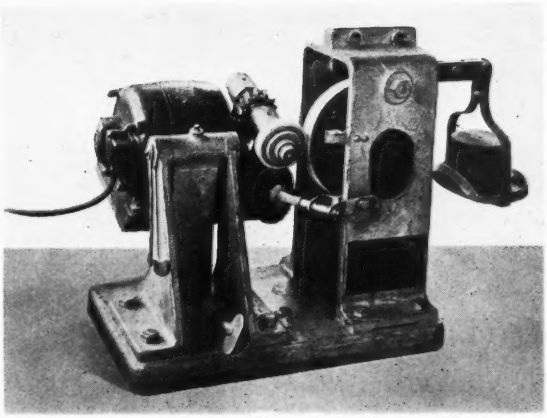
The German synthetic rubber industry can probably claim to be the oldest, since it produced commercial

types which were used during the Great War. The quality was not good, however, and after the exigencies of the war period production was dropped, and investigations were not again started in earnest until 1926. In the German process the raw materials required are coal and chalk, which in an electric furnace are converted into calcium carbide. From the latter, by the action of water, acetylene is prepared, and this is converted by further stages into the real raw material of synthetic rubber—a product known as butadiene. The compound has essentially the same chemical constitution as rubber, and synthetic rubber can be formed from it by a process known as polymerisation; the latter merely builds up a larger unit, which may be crudely compared with the rolling of a giant snowball from a small one.

The Russian synthetic rubbers are produced from alcohol as the raw material, by what is known as the S.K.B. process. The same basic material—butadiene—can be prepared from alcohol, and this is polymerised to give the larger rubber molecules. The actual process is a long one and requires skilful control, the polymerisation process alone occupying from 90 to 120 hours, after which a "ripening" process for the synthetic rubber of three to eight days is necessary.

The American synthetic rubbers differ somewhat from the others, for the basic material in one case is what is known as a chlorinated butadiene—chlorine being combined with the butadiene. This product also can be polymerised and a synthetic rubber prepared which is similar in properties to the others, but which differs chemically in having a chlorine constituent. It is of interest to note that one of the raw materials here also is acetylene. Another American synthetic rubber, Thiokol, differs from the others in that it is a sulphur-containing compound; as marketed the material is prepared by the chemical interaction of ethylene dichloride and a soluble polysulphide compound. This type has been in commercial production since 1931, and the process is stated to occupy only five hours as against the five years during which rubber trees must grow before they are suitable for tapping.

The American synthetic rubbers have so far been the only ones produced on a commercial scale in a free market, the German and Soviet Russian products owing their development to the policy of the respective governments with regard to essential raw materials. Recently, however, types of German synthetic rubber have been offered on the English market. Duprene, one of the American types, is produced in three stages, and it is estimated by experts that an average yield of about 85 per cent. may be looked for under the best operating conditions, at each stage, giving a final yield of about 60 per cent. synthetic rubber from the basic material. A complete conversion of the latter could never be attained, since it has been found that if the polymerisation process is carried on too far a tough material results which cannot be fabricated into useful finished products. On this basis each pound of acetylene would yield a pound of Duprene. At present the price is approximately five times that of natural rubber, but increasing demand, coupled with the discovery of uses for some of the by-products, will undoubtedly result in the prices being brought closer together.



Testing the wearing quality of synthetic rubber on an abrasion machine.

Accurate data with regard to the German and Russian products are not readily available. Information regarding Russian synthetic sources is to the effect that considerably over 20,000 tons was produced in 1935, with 70,000 tons aimed at this year. The actual yield from alcohol is stated to have been improved from 14.42 per cent. in 1934 to 23.09 per cent. in 1935, but no reliable information is available with regard to costs. Judging from the yield figures and the statistics on the number of workers engaged in the industry, however, the cost of production is considerably higher than that of the American synthetic rubber. The Soviet attitude to cost is rather different from ours, though, and is revealed in a reply by a Moscow paper to a criticism by the late Thomas A. Edison, expressing scepticism that a satisfactory method producing synthetic rubber on a commercial scale had been discovered in the Soviet Union. The reply runs as follows:—

"The arguments of the ingenious inventor are in need of just one correction: all his assertions that the problem of producing synthetic rubber on an industrial scale cannot be solved for the reason that the cost of primary materials entering into the synthesis considerably exceeds the cost of the natural rubber obtained by the cheap labour of colonial slaves, refer to capitalistic economy. Under socialistic conditions these problems

are solved in a different manner, and the balance sheet in this case shows a somewhat different result." The Russian object is to save foreign exchange by curtailing the imports of rubber, and to be independent of foreign raw materials in case of war.

The German position is similar to the Russian in the primary objects for the production of synthetic rubber, but if the price at which certain varieties are being offered for sale in this country can be taken as a criterion, the costs of production are of a similar order to those in America. Accurate data as to yields of "Buna" rubber is not available but early in 1936 production was given at about 600 tons per month. The German industry is producing several types of synthetic rubber and more will be said about this in discussing future development.

The cost of production of natural rubber on a well managed estate is considerably below the market price of 9½*d*. per pound. The latter is the price resulting from the present output control scheme, and production has been limited to less than the maximum possible, while no new planting is to be carried out. Research has increased the yield per acre to 1,200 lbs. as the figure to be expected with good cultivation, but the present average is only 400 lbs. Whatever the actual selling price, therefore, production costs should tend to decrease, and there is little prospect of synthetic types of rubber competing solely on a price basis.

Oil and Friction Resistance.

Very scanty information is available regarding the quality of the Russian synthetic rubbers, but there is some indication from Russian publications that those in charge of plants using them, chiefly boot and shoe factories, do not believe them equal to the natural product. More data are available with regard to the American and German types and many improvements in performance over natural rubber products are established facts. All types give a far greater resistance to the action of animal, vegetable, and mineral oils, in which ordinary rubber deteriorates to a marked extent depending upon the method of compounding. Products can now be prepared which are completely unattacked by fatty oils and mineral oils, even the lightest. Synthetic rubber compounds can be prepared which have superior abrasion resistance to any known ordinary rubber compound, the results obtained on the test machine depicted on p. 247 showing the former to wear over 50 per cent. better. In this machine the rubber is abraded against an emery wheel, the particles being brushed away by means of a rotating brush. These results have been confirmed on the road, and in Germany tyre mileages of 75 per cent. and even 100 per cent. greater than normal have been claimed with the synthetic materials. The ageing of the synthetic rubbers is also better than with the natural product, and this has been confirmed by actual experience with manufactured goods.

Synthetic Balloon Fabrics

Gases diffuse less readily through synthetic rubber compositions, a matter of importance in balloon fabrics and the like. A synthetic-rubber-coated balloon fabric showed a leakage only one-seventh that of a normally proofed fabric, and after use for several months the ageing of the latter had increased the leakage in this case considerably more than with the synthetic material.

The possibilities of the new products in many directions will be obvious from the above. The American products are being used largely on motor cars for petrol conveyor tubing, and other oil-resisting purposes; their employment on aircraft for similar purposes is developing rapidly. In the printing trade the rubber rollers and blankets that impress the paper to receive the right amount of ink have long given trouble through the swelling effect of the ink chemicals. To-day synthetic rubber compositions which are entirely free from this defect are in use on the presses of some of the largest newspapers. Because of the resistance of ozone, synthetic rubber compositions are used as a corona-proof sheath in high-tension power cables.

The odour of the early types of synthetic rubber was very pungent, and the fumes, when hot, a serious disadvantage in manufacture. Later types have been considerably improved in this respect, however, and while the odour would still be objected to for many purposes, such as household goods, for most commercial applications there is now no objection raised. There is every reason to hope for still further improvement in this direction.

The electrical properties of synthetic rubbers are inferior to those of the natural product in some respects, such as power factor and dielectric constant, but superior in others, such as the voltage breakdown. In general, synthetic rubber compounds offer more resistance to extension and compression by light loads than similarly compounded rubber stocks, and recover their original shape slightly more slowly and less completely. Improvements are taking place so rapidly, however, that any generalisation may be found to-morrow to be incorrect.

Probably several different types will be necessary to give the best results for the many different applications possible; but synthetic rubber is only on the fringe of its development in commerce and it should be regarded rather as a new raw material than in the light of a competitor of the natural product.

Near Eastern Excavations

Our archæological correspondent reports the extremely interesting work performed at Lachish in Palestine and Sesebi in Nubia during the past season. Some of the most important finds have justly been deemed worthy of exhibition in London.

THE annual exhibition of antiquities excavated by the Wellcome Marston Archæological Research Expedition to the Near East year by year at Tell el-Duweir (Lachish) is becoming one of the established institutions of the London archæological "season." The exhibition, on view at the Wellcome Research Institution, Euston Road, from July 12th to August 7th, shows no falling off in archæological interest. Last season's operations were directed to three objectives—the examination of the ground at the north-east corner of the Tell, where it rises from the valley to the level of the moat of the Hyksos period (1700-1555 B.C.); the investigation of the character and purpose of the great excavation or rock-cut shaft on the eastern edge of the mound; and the examination of the roadways at the main south-west gate, and the rising ground which lies behind to the east, reaching up to the walls of the Jewish palace.

The Lachish dagger with pictograph inscription.

The ground at the north-east of the Tell is honeycombed with caves and rock tombs, which show evidence of occupation from the Middle Bronze Age to Byzantine times. The examination of some of these tombs yielded a number of smaller antiquities, notably scarabs, one family tomb yielding close on two hundred of these. A complete consecutive series of royal scarabs belonging to the XVIII and XIX Dynasties have now been found.

The greater proportion of the work of the season was devoted to the investigation of the great shaft which was discovered in 1935.

Two negroid heads, from the temple façade at Sesebi

This was filled with water-borne débris overlying stones from the collapsed Jewish walls. It has been estimated that to clear this shaft would involve the removal of no less than half a million loads of material. A shaft was sunk to the bottom, and from this tunnels were carried along two sides, just turning the far corner into the third side. It was found that the dimensions of the shaft are: length, 85 ft; breadth, 75 ft; and the depth of the contents 90 ft. The uneven character of the floor, which showed the method of working by undercutting the rock, indicated that the shaft was left unfinished, probably owing to frontier troubles towards the end of the Jewish kingdom. The work was probably carried out under Zedekiah, though it may have been begun under Josiah towards the close of the 7th century B.C. A model, exhibited, showing the method of investigation, gives a very good impression of the magnitude of the work. Its purpose is still a matter of conjecture, as attempts to reach the centre have failed owing to the loose packing of the stones. No evidence of either exits or means of access have been discovered.

The excavation of the gate area and the terrain behind provided some interesting results. Behind the gate deep deposits of water-borne material had accumulated, owing to the blocking of the drainage by the fall of the gateway before enemy assault where the roadway fell sharply to meet the sill of the inner gate. Carbonised material provided evidence of conflagration and from the evidence of stratification it was possible for the first time to provide tangible archæological evidence of the two Babylonian assaults of 597 B.C. and 588 B.C., of which the record previously has been confused. It was also clear that the guard or muniment room, in which the famous Lachish letters, now in course of publication by Dr. Harry Torczyner, were discovered, had been

built in the interval between the two assaults.

Laying bare the foundations of the walls of the Jewish palace provided some interesting ceramic evidence in the form of fragments found among the débris from former occupations which had been used as packing for the foundations. Among this, with fragments of local ware, were sherds of Ægean pottery showing the characteristic curvilinear decorative motifs.

Engraved Bronze Dagger

Among the antiquities exhibited pride of place must be given to a dagger of bronze, although this was found in 1934. It is lent for exhibition by the Palestine Government, and has been cleaned recently by the authorities of the Museum of Antiquities at Jerusalem. It was then found to bear four engraved outlines arranged vertically, of which one is a man's head, another is thought to be a snake, and the remaining two are undeciphered. This is unquestionably a pictographic inscription. It has been pointed out by Prof. Alan Gardiner that it is late for a pictographic inscription —it belongs to the Hyksos period and is probably not later than 1600 B.C. Another discovery of some interest in this connection is a shallow bowl, which bears an inscribed record of a tribute or offering to the deity of corn in Egyptian hieratic script. The terms for numbers and measures are Egyptian, and demonstrate the use of Egyptian systems in southern Palestine at this period. Mr. J. L. Starkey, who has conducted the excavations, gives his second lecture on July 28th, at 6 o'clock.

In November, 1936, the Egypt Exploration Society entered upon a new field of investigation. An expedition under Professor A. M. Blackman of Oxford began the excavation of Sesebi, a fortress site in Nubia halfway between the Second and Third Cataracts of the Nile, and 180 miles south of Halfa. The Society was led to undertake this excavation partly owing to the approaching expiration of its concession at Tell el-Amarna, partly in the expectation of obtaining at Sesebi a fresh light on the art of the Amarna period, upon which it has been engaged for sixteen years in its investigations in the city of king Akhenaten.

It had been known that Sesebi was connected with Akhenaten since 1903, when the late J. H. Breasted discovered that the temple here had been founded by that monarch and not by Seti I, as had been supposed, Seti having covered the inscriptions of his predecessor with plaster and inscribed thereon his own name and a rededication of the building. Independent evidence indicates that probably there was an important Egyptian settlement on this spot long before the days of Akhenaten.

The results of the season 1936-7 amply justified the anticipations with which the excavation was undertaken, as was shown by an exhibition of the finds held recently at Hinde Street, W.1.

The fortress-town, about 200 metres from the river on the west bank, enclosed an area of about 270 by 200 metres. In places its walls still stand to a height of 4-5 metres. Within this enclosure the season's excavations uncovered the previously known temple, which proved on examination to be not one, but three temples side by side on a single and very solid substructure, another stone structure near-by, three rows of magazines to the south and to the south again, the south-western area of the residential portion of the town. To the west lay the New Kingdom cemetery, evidently much plundered, but yielding, nevertheless, much valuable archæological material.

So far as relates to the historical bearing of the site the most valuable indications came from the temple, which was shown to have been founded at about 1370 B.C. At the north-west and south-west corners of the substructure were found four sets of foundation deposits intact. These included inscribed plaques of blue faience and a large inscribed scarab of the same material, which show beyond question that the temple was founded by Amenophis IV. He had not yet changed his name to Akhenaten—a change made in the fourth year of his reign. Further evidence assigning the temple to the earlier phase of this monarch's reign was forthcoming. Below the central temple was found a crypt, on the walls of which the king was represented, sometimes with the queen, seated in the company of deities of the Egyptian pantheon. These figures, which it is to be noted are in the ordinary style of XVIII Dynasty art, and not in that of the Amarna period, belong therefore to the time when the king was still a polytheist and before he had turned to the monotheistic worship of the Aten. Further, the stone structure near the temple group, already mentioned, which was built by Akhenaton and was reconstructed at least once, appears in its original form to have been a temple of the sun. The discovery of a crypt below the central temple is in itself remarkable. No temple crypt was known previously of an earlier date than that of the Ptolemaic temple at Denderah of, it may be, 1300 years later.

The residential and cemetery areas yielded an interesting collection of smaller antiquities, including a number of scarabs, amulets, pottery, and a number of toys, models of various animals. From the tomb groups came several bronze mirrors and a bronze bowl, while among the beads were a remarkable amulet in green felspar in the form of a baboon and a *millefiori* bead in its original gold setting.

Owing to pressure on space, "The March of Knowledge" is held over until next month.

Book Reviews

Sound Applications of Psychology.

In the Realm of Mind. By CHARLES S. MYERS. (Cambridge University Press, *7s. 6d.*)

This useful and stimulating book consists of nine chapters all based on lectures given by Dr. Myers in the last few years. Nothing seems to be earlier than 1931, or, if the original lecture was a little earlier, it has been revised and brought up to date in any matters which needed change. The work was well worth doing, and the book, beside its special lessons for particular occasions, touches lightly on several great topics which it is to be hoped Dr. Myers will some day develop more fully. The general characteristic of his view is a broad-mindedness which refuses to accept any narrow or exclusive creed but seeks for a solution which, while maintaining the value of psychological study, allows for wide difference in its interpretation and uses.

Two of the essays illustrate this temper very well in different ways. One, following more accustomed lines, finds a hopeful advance towards a wiser internationalism which will reconcile and not suppress national idiosyncrasies. Here the psychological bias of the author shows itself—quite rightly—in according a decisive influence to the "social mental environment" of the individual. There is something beyond and above each individual which carries him farther in the common direction than we might judge possible from his own aptitude and feelings. This "something," by the way, is one of the several great topics which call for more thorough investigation than is possible in an occasional address. The other, wisely reconciling, paper is that on "Musical Appreciation" in which Dr. Myers takes up again a study which he had pursued for twenty-five years between 1898 and 1922. It bears therefore the appearance of more complete mastery than some of the others and will appeal strongly to musical experts. He analyses the four quite different effects of music on the hearer and concludes characteristically that the "fullest and highest appreciation occurs when the whole of its varied and complex influences are in the most perfect harmony."

The paper which arouses the keenest desire for further development is the last, on the "Nature of Mind." This contains material for a full and up-to-date treatise on the position and conclusions of psychology. Its features are a careful analysis of various levels of mental activity, based, as it must be in the first instance, on personal introspection but extended as far as possible into the minds of other creatures. Here we have the fullest acceptance of the evolutionary standpoint and an attempt to carry out the implications of evolution in the rise and growing complexity of the mind. One general sentence sums up the position and is again markedly comprehensive—"The acts at this highest mental level constitute the purposeful directive creative and contemplative self, and are the recipients of presentations from the lower cortical and also of feelings from lower, primordial, thalamic activity." All which, it will be seen, calls for much more explanation, illustration and application than can be given in thirty-five pages.

F. S. MARVIN.

The Ancient Norsemen

Scandinavian Archæology. By HAAKON SHETELIG and HJALMAR FALK. Translated by E. V. GORDON. (Oxford University Press, *21s.*)

Dr. Shetelig's survey of Scandinavian archæology from the beginnings down to the Viking age is of importance as placing before English readers a full and authoritative account of recent research in a field of archæological studies, that is not as well known generally as it should be. Scandinavia is of interest not only as exemplifying the development of a civilisation in a geographical environment of strongly marked individuality, but also because in each successive phase of pre history its evidence is of first rate significance in its bearing upon continental conditions, at times in Northern Europe only, and at times over the continent as a whole. As an instance of the former may be cited the investigations now being carried out in an attempt to trace the earliest and most northerly settlements of man in early post-glacial times, which seem likely to modify with an approach to finality accepted views on the extent and distribution of habitable territory in early times. No less important in its implication for continental conditions as a whole is the evidence bearing on the sources and routes of distribution of amber.

A truly remarkable development of Scandinavian civilisation is the efflorescence of artistic activity which appears first in what is known as the Arctic Stone Age and again later in the Bronze Age. Studied in relation to funerary and religious offerings, it throws a remarkable light on cultural and religious development. Dr. Shetelig's treatment of the Migration period, the gold hoards, and the Merovingian age will be found invaluable, while the collaboration with Dr. Falk has produced an illuminating reconstruction of northern culture in its various provinces, which concludes a book that is as absorbing as it is easy to read.

E. N. FALLAIZE.

Familiar Studies of Birds

A Bird Lover's Britain. By G. K. YEATES. (Philip Allan, 15*s.*)

What delightful photographs! There are 74 of them, mostly of birds at the nest, in their lovely settings of twigs and leaves and reeds and pools. Even in this era of skilled photography, these pictures are still exceptional; especially those of the larger, water-haunting birds, for photographs of some of our smallest and most common birds are, for various reasons, not always easily recognisable.

Nor is this one of those books—alas! too frequent—in which the reading-matter serves but as a pretext for the inclusion of the photographs. Mr. Yeates sets out to tell us of most of our English birds according to the nature of their habitat, writing, chapter by chapter, of the birds of the lane, of the birds of the heath, and so on, and ending with the lesser known territories of loch and peat bog. In so doing he brings some of the beauty of our English countryside alluringly before that "inward eye" of which Wordsworth speaks, and even if our author's prose does not wing its way as gracefully as his birds, or change its hues as lightly as the changing countryside of which he writes, it would be ungrateful to blame him for that.

Mr. Yeates has determined, as he tells us, to steer midway between two courses, and give us a book which shall not be too technical and scientific nor, on the other hand, too popular, and he does so not without success. But is there any real dilemma? Some of the best work in this field has been done by observers who, like Howard, were but gifted amateurs; and Hudson is equally delightful to one who knows much of birds or little. Only, whoever is the reader, he will want to hear sufficient of each bird to make an intimate picture of its life, and the more he knows the more he will want to hear; and for our part we liked best the latest chapters where Mr. Yeates writes more fully and sympathetically of the less familiar denizens of Highland tarns and Shetland wastes. Above all, no one wants theories as to how such and such a curious habit arose, for no one knows anything of these things; and in those very few places where the author theorised we confess we were reminded of Goethe's words written of Byron: "So bald er reflechiert ist er ein kind." But this is a paltry detail, and amounts to nothing compared with the pleasure that the reader will derive from these pages.

A. S. DIAMOND.

British Insect Lore

Insects of the British Woodlands. By R. NEIL CHRYSTAL. (Warne, 7*s.* 6*d.*).

This book, which is well produced, with numerous and helpful illustrations, should be very useful to all who are concerned with the management of woodlands, whether forestry officers or private owners, and at the same time to entomologists and naturalists in general. It gives a clear outline account of the chief orders of insects occurring in woodlands, dealing with their structure and habits. Chapter VIII discusses questions of a general nature, for example the conditions under which insect attacks arise in forests, and various aspects of their control, with some simple instructions for the collection and study of such insects and their work. There are descriptions of the most important species, from the forester's point of view, and, perhaps most important of all, a good bibliography. This will be very helpful, as the literature is so very scattered.

A great deal of work has been done in Germany on the question of the capacity of birds for good and evil, and the author quotes the opinion of Professor Karl Escherich that the first of the list of beneficial birds is the cuckoo, which he considers most valuable because it is partial to hairy caterpillars which most birds avoid. Next on the list comes the starling. The encouragement of birds has, it seems, been unduly neglected by the forester, which is strange, as it is his primary concern to build up a bird population in the forest area, for which it is the natural police force, although, of course, as Escherich says, birds cannot be relied upon to reduce outbreaks to order.

The most important birds, according to the evidence of numerous British workers, are the tits and the nuthatch, with the starling, robin, redstart, tawny owl, and great spotted woodpecker. The small warblers, of course, are all useful. It is somewhat surprising to find the green woodpecker, with the chaffinch, rook, barn owl, little owl, and kestrel in the merely "useful" class, while sparrowhawk, black game, and capercaillie are condemned "to be exterminated at all times." Of a truth, conflicting interests can produce queer results.

There are many passages which are readable for their own sake, such as the description of the remarkable performance of oviposition by *Rhyssa*, which leaves an indelible impression on all who have watched it. The insect, after a thorough scrutiny of the log in which she seeks the boring grub, chooses the likely spot, and with her long, slender fretsaws, working with incredible rapidity, drills a hole through the solid wood, down to a depth of one and a quarter inches, in twenty minutes. She then stings her prey, the woodwasp larva, to paralyse it, and upon it deposits her egg.

MALCOLM BURR.

The New Age of Exploration

The Unveiling of Arabia. By R. H. KIERNAN. (Harrap, 12*s.* 6*d.*)
The Story of Twentieth Century Exploration. By C. E. KEY. (Harrap, 7*s.* 6*d.*)

It is favourite commonplace in the mouths of the multitude to say that the age of exploration is dead, or at all events dying. Here are two books that go far to show how inaccurate this generalisation, like most of its kind, is. Mr. Kiernan's book deals, of course, with Arabia throughout the centuries; but it is with his latest chapters, on 20th-century explorers, that we are most enthralled. Burckhardt, Burton, Doughty, and Palgrave—to mention no others—did magnificent work and wrote notable accounts of their adventures. But it is in the somehow more impersonal records of Thomas and Philby that the true essence of exploration, in the fully scientific sense, appears to be contained. This is not to belittle the literary work of these great modern explorers—and Mr. Kiernan does them full justice—but there lies in their work a sort of calm thoroughness that their more picturesque predecessors miss partly by their very picturesqueness, and partly, no doubt, because modern scientific equipment encourages methodical work.

Mr. Kiernan's own method, wisely selective and wisely avoiding the transliteration puzzle, is an admirable one. It has enabled him to compress into a reasonable compass a readable, well-documented account of the history of his subject, which may well encourage future explorers of the peninsula to add another track on the map to the many which now crsss it.

Mr. Key, perhaps surprisingly, makes no mention of Arabia in his account of this century's exploration, apart from a prefatory apology for the omission. His heart is in the snows, and of his twelve chapters seven are devoted to either polar expeditions or to climbs on "the roof of the world"; even the African section

deals largely with the ice-clad summits of Ruwenzori. Mr. Key's selection is perhaps justified, as it is in these chilly regions that our knowledge of the earth's surface has increased to the greatest extent in the last 37 years.

The method followed is a selective one, similar to that of Mr. Kiernan. Certain outstanding expeditions are treated with a fair amount of detail, while others are omitted altogether; the result gives on the whole a satisfactory purview of the course of this century's exploration; and it whets our appetite for more.

Both books are enormously indebted to the work of the Royal Geographical Society, a debt which is handsomely acknowledged in both cases. The illustrations are well produced and well selected, though a little more care might have been taken in editing one or two of the captions: "Makahi" comes as rather a shock in a panoramic view of the Everest group.

Cosmology and Health

Secrets from Nature. By Lt.-Comdr. C. Felton, M.B.E., R.N. (Fisher, Knight, 15*s.*)

This is a book written in a popular style—a general cosmology incorporating many original views on both physical and biological evolution. The author postulates a fundamental underlying principle of creation and radiation which he calls Ra—reference to which occurs with rather irritating frequency throughout the work. The narrative is told in the first person and is in the form of a dialogue between the inquirer and Nature. Treatment of the subject would have been better executed in some definite systematic form, the chapters being arranged to deal first with physical phenomena, then with biological evolution, concluding with the general health principles which occupy the middle of the book. Such a scheme would then have a natural orderly sequence.

The author's remarks on the physical system of the universe are certainly unique and strike an entirely original attitude towards such phenomena as gravitational mechanics and wave-motion. There is rather too great a confusion of terms concerning the molecular conditions of things; he brings atomic and molecular movement irrelevantly into quite commonplace physiological phenomena. We recognise, of course, that there is an underlying "vibratory characteristic" for every form of activity, but it is unnecessary to refer thereto when treating of such matters as health and hygiene. Nevertheless, the sixty-eight pages devoted to health are the most interesting of all. The essence of his remarks is summed up in the author's statement—"Your happiness entirely depends on your physical condition," he concludes the chapter—". . . .Diseases of variety are nothing more or less than the result of how people feed themselves, eliminate their bowel and exercise their body," and "Living is the greatest of all cults; to live at one's best requires profound physiological study. . . ."

Chapter XXI deals with "Spectroscopy" and the views expressed do not accord with those to be found in text-books on the subject. The facts of spectrum analysis are refuted—it is stated that many errors on this subject must be in the separate prismatic effect of the diffraction gratings and lenses used in the analysing instruments. These statements are opposed to the findings of modern research; the work of the Solar Physics Observatory at Cambridge and other institutions all over the world goes to show that at least sixty-one elements have been detected in the sun, while many others promise to be shortly revealed—among the more recent additions are osmium, iridium and thulium. The following chapter on "Meteorology" is more in the author's province and there are some interesting details of cyclonic disturbances.

To the general reader who requires an idea of "first principles" and a popular outline of evolutionary science this work may help to stimulate a thirst for more technical data. Greatest benefit is to be had from the chapter on "Health and Diet."

Frank W. Britton.

A Monument to Peary.

Peary. By W. H. Hobbs. (The Macmillan Co., New York, 25*s.*)

A biography of five hundred closely-written pages is not in itself a bad thing, but to be readable it requires either special talent on the part of the writer or outstanding interest in the subject. It is not enough, therefore, that Peary should have been a thoroughly competent explorer, and that Mr. Hobbs should be a thoroughly painstaking biographer.

It is scarcely possible for an English reader to be interested in the behaviour of the young Peary at preparatory school when all the time he is thinking "did Peary reach the Pole?" Mr. Hobbs does not seem to realise that his book closely follows another which very convincingly sought to prove that Peary did not reach the Pole, and the only defence he puts up to the arguments against Peary is a table justifying the long sledge journeys. One of the strongest arguments against the genuineness of Peary's discovery of the Pole is the fact that his marches of sixty and more miles a day over ice, which were necessary to dovetail his observations and times, were longer than normal. Mr. Hobbs gives a table of dog-sledge journeys under similar conditions "by others," but the names given for marches of over 35 miles are only Capt. R. A. Bartlett and Eskimo Seegloo (both of whom were alleged by doubters to be in league with Peary) and R. L. Belknap. This table is unconvincing without the names of Nansen, Amundsen, Scott, or any other famous figures. The suspicious circumstances of Marvin's death when out with the Eskimos, and the rumours it gave rise to, are not mentioned.

In fact, instead of a spirited defence of a hero, we get a plodding, heavily documented history, with family tree and list of medals awarded. Mr. Hobbs believes in Peary, but he believes so implicity that he does not bother to deal with criticism. True, he devotes some space to showing the full rascality of Cook, but the fact that Cook was a fraud does not make Peary genuine.

It is not pleasant to have to criticise adversely a book which is perfectly produced and is a monument of industry; but the general reader's verdict will be that if a sympathetic portrait of Peary was desired, it might have been more human, and if a justification was intended, then it could have been much more convincing.

The Poetry of Science

The Torch Bearers: A Trilogy. By Alfred Noyes. (Sheed and Ward, 7*s.* 6*d.*)

Life, observed Dr. Johnson, that invaluable aphorist, is a pill which none of us can bear to swallow without gilding. Others have made similar remarks; in this work Mr. Noyes applies his gilt with a lavish indifference to the cost of the process, in an attempt to light the way of our going by the twin torches of science and religion. The first part of the trilogy deals with the lives and work of seven great astronomers from Copernicus to the Herschels; the second with some of those who may be

broadly classified as scientist-sages, from Aristotle to Darwin. His method in each case is to select, or invent, some adequately dramatic incident in the life of his subject, and encompass his work for knowledge and thought within the romantic efflorescence evoked. The third part, somewhat melodramatic in treatment, sets out the struggle of life and death during a few hours of an Atlantic crossing, moving through a strongly personal note of pathos to a deeply religious close. These three books put the question Whither ? and Mr. Noyes is in no doubt about the answer. From the highest peak of knowledge he sets out, supported by all the confidence of faith, into—he is scarcely expected to tell us what. But all will be well.

The narrative power of the work is well sustained, and by agreeable variations of metre he seldom allows monotony to overtake his verse. But whilst it is perhaps scarcely inappropriate that "The Torch Bearers" should be flamboyant, the rain of adjectives, all highly-coloured, at times submerges the comparatively few concrete images we are allowed. Incidentally, whatever the capabilities of philosophy, verse, especially epic verse, cannot sustain constant references to vast abstractions—the one impossible Fact, and so on. In his passage on the Evolution-Wilberforce controversy, Mr. Noyes is at his dullest, in his description of the Grand Canyon and its effect upon him his pen runs away with him. It is with the monologue which he puts into the mouth of Leonardo that Mr. Noyes reaches his best ; the verse has dignity, beauty, and extra-narrative meaning.

Synthetic Rubber. By W. J. S. NAUNTON. (Macmillan, 7*s*. 6*d*.)

This is the first book on synthetic rubber to deal with both technical and economic aspects. As head of the rubber laboratories of Imperial Chemical Industries, Ltd., and honorary technical adviser to the Institution of the Rubber Industry, the author speaks with authority on the technical advances and changes in industrial outlook which in the last ten years have made the large-scale production of synthetic rubber practically possible and economically desirable. Three chapters summarise the history, economics and future outlook of synthetic rubber. They trace the history of this material from the early "academic synthesis" period, through the techno-commercial period, up to the present time when it is realised that only by improving upon the natural product can the synthetic material hope to succeed. The author's main conclusion is that there is a great field for development in a product which gives better service than natural rubber, even though more expensive. He suggests that increased knowledge of the relation between the chemical and physical structures of synthetic rubber should eventually make it possible to produce a synthetic rubber to meet particular requirements.

Chemistry, Matter and Life. By STEPHEN MIALL and LAWRENCE MACKENZIE MIALL. (Arnold, 7*s*. 6*d*.)

There appears to be no end to the writing of books on the subject of chemistry considered from various aspects. School text books, specialised monographs, and books for the science-loving public, come in endless profusion, each having something to say like so many Hyde Park orators and yet serving so little true purpose that the world would not be particularly poorer by their non-appearance. Because the structure of atoms and molecules has become in recent years a subject of common discussion, one more new book is now published to show how these "chemical building bricks" unite to form matter and of how life itself and all its processes are based on the interactions of atoms and molecules. The authors explain how atoms unite to form molecules, and how molecules join up to provide a vast range of substances ; they tell us about the rare gases in the atmosphere, about the nature of X-rays, of the powers of radium, and how the atom is being "split" by modern investigators who are meddling with unknown forces. Digestion, the subject of how plants grow, vitamins, and the wonderful colouring of the flowers, all receive treatment in turn, and it is not to be doubted that the reader will finish his readings with a clearer idea of the place of chemistry in the material universe and in the processes of life, but to what particularly useful purpose it is not stated.

Shorter Notices.

Legendary London (LEWIS SPENCE. Robert Hale, 12*s*. 6*d*.) collects the various tales, historical and pseudo-historical, regarding London in the pre-Roman and Roman eras and in the Dark Ages that followed. Mr. Spence has had a difficult task, as the available material is singularly sparse and, it must be confessed, not as enthralling as it ought to be ; but he has contrived to make an exhaustive collection of what there is. It would appear that the Londoner's casualness is a disease of long standing and probably incurable.

The Observer's Book of British Birds (S. VERE BENSON) and *The Observer's Book of British Wild Flowers* (W. J. STOKOE), both published by Warne at 2*s*. 6*d*., are unusually good value. Each contains two hundred illustrations, mostly in colour. Each species occupies one page, and the whole is neatly laid out and indexed. The illustrations are clear, and in the case of the flowers, remarkably faithful ; the bird pictures in colour have the common failing of a preponderance of brown tone. The size of the books (5½ x 3½ inches) gives them real "vest-pocket" utility, and it is difficult to see how they could have been improved in any respect.

Vagrant in Summer (NINA MURDOCH. Harrap, 8*s*. 6*d*.) is another of this author's pleasantly discursive essays on European travel. On the whole, she has succeeded in conveying, with vision and clarity, the atmosphere of the lands she visited, notably Portugal, but her occasional tentative excursions into political psychology are less perceptive. Austrian sympathies evidently placed her out of tune with the Italian Tyrol ; and to accuse the Italian authorities of political motives in altering street-numbers is equivalent to attributing communistic motives to the L.C.C. in their recent changes of London street-names. At approximately the same date as Miss Murdoch's visit, moreover, this reviewer was actually sketching in the streets of Bolzano and (singularly, it would appear) was quite unmolested. As an experienced traveller, Miss Murdoch should know that a visitor to a foreign country usually receives the treatment he expects.

Books Received

Westward Bound in the Schooner Yankee. By CAPTAIN and MRS. IRVING JOHNSON. (Robert Hale, 15*s*.)
Archæological Reconnaissances in North Western India, etc. By SIR AUREL STEIN. (Macmillan, 63*s*.)
Atomic Structure of Minerals. By W. L. BRAGG. (Oxford University Press, 18*s*.)
The Nile in Egypt. By EMIL LUDWIG. (Allen & Unwin, 16*s*.)
Aeroplanes and Aero Engines. By P. H. SUMNER. (Technical Press, 15*s*.)
The Grammar of Science. By KARL PEARSON. (Everyman's Library. Dent, 2*s*.)
General Science. By I. C. JOSLIN. (Macmillan, 4*s*. 6*d*.)
Modern Glass Working and Laboratory Technique. By M. C. NOKES. (Heinemann, 7*s*. 6*d*.)
Island Memories. By J. W. DOUGAL. (Moray Press, 5*s*.)
The Peat Fire Flame. By A. A. MACGREGOR. (Moray Press, 12*s*. 6*d*.)

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